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ABSTRACT

Guidelines for playground equipment safety are presented in this handbook. It first provides an overview of common playground injuries and definitions. The layout and design of playgrounds, such as choosing a site, locating equipment, and separating equipment by age level, is addressed next. The remaining sections describe the installation and maintenance of equipment, standards for manufactured and constructed materials, general hazards, access and platforms, major types of playground equipment, surfacing, and use zones for equipment. Two tables and 18 figures are included. Appendices contain a suggested general maintenance checklist, entrapment requirements and test methods, characteristics of organic and inorganic loose-fill materials, and unitary synthetic materials, and a description of loose-fill materials. (Contains seven references.) (LMI)

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HANDBOOK FOR PUBLIC PLAYGROUND SAFETY

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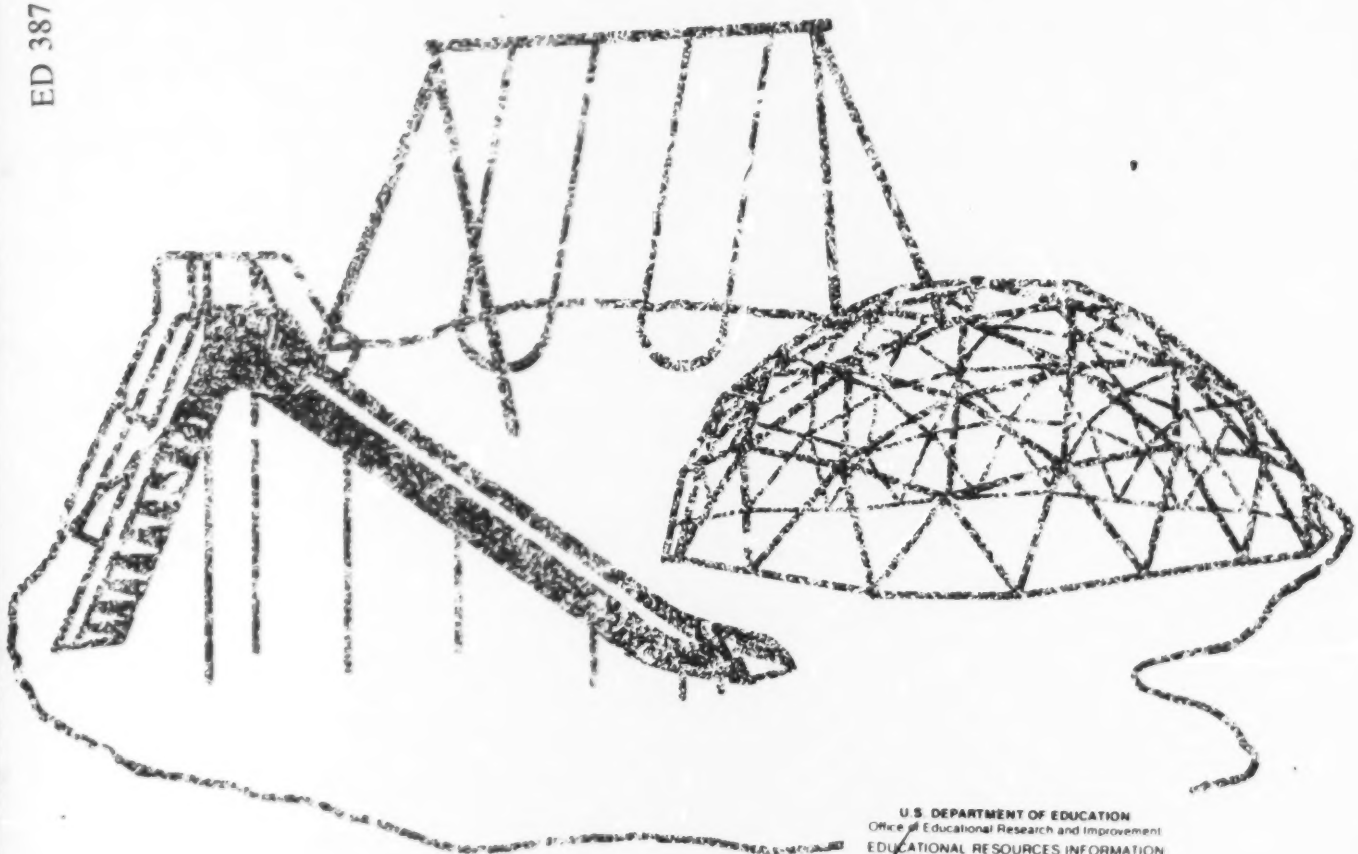

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1. INTRODUCTION

This handbook presents playground equipment safety information in the form of guidelines. Because many factors may affect playground safety, the U.S. Consumer Product Safety Commission (CPSC) believes that guidelines, rather than a mandatory rule, are appropriate. The safety guidelines for equipment are based on recommendations provided to the CPSC by COMSIS Corporation in a March 1990, report [**1**]*.

The handbook is intended for use by parks and recreation personnel, school officials, equipment purchasers and installers, and any other members of the general public concerned with public playground safety such as parents and school groups. A voluntary standard, to be published by ASTM, will contain more extensive requirements for manufacturers of public playground equipment.

"Public" playground equipment refers to equipment intended for use in the play areas of parks, schools, child care facilities, institutions, multiple family dwellings, restaurants, resorts and recreational developments, and other areas of public use. The guidelines are not intended to apply to amusement park equipment, equipment normally intended for sports use, or to home playground equipment. Equipment components intended solely for use by the handicapped and necessarily modified to accommodate such users safely are also not covered by these guidelines.

The safety of each individual piece of playground equipment as well as the layout of the entire play area should be considered when evaluating a playground for safety. The installation of protective surfacing under and around all equipment is crucial.

Because all playgrounds present some challenge and because children can be expected to use equipment in unintended and unanticipated ways, adult supervision is recommended. However, it is recognized that this may not be possible for some playgrounds. Equipment design, layout, and maintenance, as discussed in this handbook, are essential for increasing public playground safety.

A playground should allow children to develop progressively and test their skills by providing a series of graduated challenges. The challenges presented should be appropriate for age-related abilities and should be ones that children can perceive and choose to undertake.

Preschool and school-age children differ dramatically not only in physical size and ability, but also in their cognitive and social skills. Therefore, age-appropriate playground designs should accommodate these differences with regard to the type, scale, and the layout of equipment. Recommendations throughout this handbook address the different needs of preschool and school-age children; "preschool" refers to children 2 to 5 years old, and "school-age" refers to children 5 to 12 years old.

These guidelines are not a CPSC standard and are not mandatory requirements. Therefore, the Commission is not endorsing them as the sole method to minimize injuries associated with playground equipment. The Commission believes, however, that the safety features in many of the recommendations in this handbook will contribute to greater equipment safety. Publication of the handbook is expected to promote greater safety awareness among those who purchase, install, and maintain public playground equipment.

2. PLAYGROUND INJURIES

The Consumer Product Safety Commission has long recognized the potential hazards that exist with the use of public playground equipment. A Commission study [**2**] of playground equipment-related injuries treated in U.S. hospital emergency rooms indicated that the majority resulted from falls from equipment. These were primarily falls to the ground surface below the equipment rather than falls from one part of the equipment to another part.

Other hazard patterns involved impact by swings and other moving equipment, colliding with stationary equipment, and contact with such hazards as protrusions, pinch points, sharp edges, hot surfaces, and playground debris. Fatal injuries reported to the Commission involved falls, entanglement of clothing or other items on equipment such as slides, entanglement in ropes tied to or caught on equipment, head entrapment in openings, impact from equipment tipover or structural failure, and impact by moving swings.

The recommendations in this handbook have been developed to address the hazards that resulted in these playground-related injuries and deaths. The recommendations include those which address the potential for falls from and impact with equipment, the need for protective surfacing under and around equipment, openings with the potential for head entrapment, the scale of equipment and other design features related to user age, layout of equipment on a playground, installation and maintenance

* - Numbers in brackets indicate references that are listed at the end of this handbook.

procedures, and general hazards presented by protrusions, sharp edges, and pinch points.

3. DEFINITIONS

Composite Structure - Two or more play structures, attached or directly adjacent, to create one integral unit that provides more than one play activity (e.g. combination climber, slide, and horizontal ladder).

Entrapment - Any condition that impedes withdrawal of a body or body part that has penetrated an opening.

Fall Zone - The surface under and around a piece of equipment onto which a child falling from or exiting from the equipment would be expected to land.

Footing - A means for anchoring playground equipment to the ground.

Guardrail - An enclosing device around an elevated platform that is intended to prevent inadvertent falls from the platform.

Infill - Material(s) used in a protective barrier to prevent a user from passing through the barrier.

Non-Rigid Component - A component of playground equipment that significantly deforms or deflects during the normal use of the equipment.

Preschool Age Children - Children from 2 years of age to not more than 5 years of age.

Protective Barrier - An enclosing device around an elevated platform that is intended to prevent both inadvertent and deliberate attempts to pass through the barrier.

Protective surfacing - Surfacing material in the fall zone that conforms to the recommendations in Section 10.2 of this handbook.

Roller Slide - A slide that has a bed consisting of a series of individual rollers over which the user travels.

School-Age Children - Children over 5 years of age but not over 12 years of age.

Tube Slide - A slide in which the sliding section consists of a totally enclosed tube or tunnel.

Upper Body Equipment - A device designed to support a child by the hands only (e.g. horizontal ladder, overhead swinging rings).

4. LAYOUT AND DESIGN OF PLAYGROUNDS

4.1 Choosing a Site

When planning a new playground, it is important to consider hazards or obstacles to children traveling to or from the playground. A barrier, surrounding the playground, is recommended to prevent children from inadvertently running into a street. Such a barrier should not preclude supervision.

4.2 Locating Equipment

The playground should be organized into different areas to prevent injuries caused by conflicting activities and children running between activities. Active, physical activities should be separate from more passive or quiet activities: areas for play equipment, open fields, and sand boxes should be located in different sections of the playground.

In addition, popular, heavy-use pieces of equipment or activities should be dispersed to avoid crowding in any one area. The layout of equipment and activity areas should be without visual barriers so that there are clear sight lines everywhere on the playground to facilitate supervision.

Moving equipment, such as swings and merry-go-rounds should be located toward a corner or edge of the play area. Slide exits should also be located in an uncongested area of the playground.

Composite equipment has become increasingly popular on public playgrounds. Care should be taken to ensure that the play and traffic patterns of children using adjacent components of composite equipment are complementary.

4.3 Age Separation of Equipment

It is recommended that playgrounds have separate areas for younger children with appropriately sized equipment and materials to serve their less advanced developmental levels. It is also important to recognize that preschoolers require more attentive supervision on playgrounds. Throughout this handbook, consideration is given to specific recommendations for equipment designed for preschool-age children (2 to 5 years).

The design and scale of equipment should make the intended user group obvious. Some playgrounds, often referred to as "tot lots," are designed only for younger children, so separation is not an issue.

In playgrounds intended to serve children of all ages the layout of pathways and the landscaping of the playground should show the two distinct areas for the two age groups. The areas should be separated at least by a buffer zone of ample physical space. Signs posted in the playground area can be used to give some guidance to adults as to the age appropriateness of the equipment.

5. INSTALLATION AND MAINTENANCE OF EQUIPMENT

5.1 Assembly and Installation

Proper assembly and installation of playground equipment are crucial for structural integrity, stability, and overall safety. The people who assemble and install playground equipment should not deviate from the manufacturer's instructions. After assembly, equipment should be thoroughly inspected before its first use.

As a precaution, the manufacturer's assembly and installation instructions, and all other materials collected concerning the equipment should be kept in a permanent file.

5.1.1 Stability

When properly installed as directed by the manufacturer's instructions and specifications, equipment should withstand the maximum anticipated forces generated by active use which might cause it to overturn, tip, slide, or move in any way. Secure anchoring is a key factor to stable installation, and because the required footing sizes and depths may vary according to equipment type, the anchoring process should be completed in strict accordance with the manufacturer's specifications.

5.2 Maintenance

Inadequate maintenance of equipment can lead to injuries on the playground. Because the safety of playground equipment and its suitability for use depend on good inspection and maintenance, the manufacturer's maintenance instructions and recommended inspection schedules should be strictly followed.

A comprehensive maintenance program should be developed for each playground as a whole. Generally, all equipment should be inspected frequently for any potential hazards, for corrosion or deterioration from rot, insects, or weathering. The playground area should also be checked frequently for broken glass or other dangerous debris.

For each piece of equipment, the frequency of thorough inspections will depend on the type of equipment, the amount of use, and the local climate. Based on the manufacturer's recommendations regarding maintenance schedules for each piece of equipment, a maintenance schedule for the entire playground can be created. The detailed inspections should give special attention to moving parts and other components which can be expected to wear. Inspections should be carried out in a systematic manner by trained personnel.

One possible procedure is the use of checklists. Some manufacturers supply checklists, for general or detailed inspections, with their maintenance instructions. These can be used to ensure that inspections are in compliance with the manufacturer's specifications. Inspections alone do not constitute a comprehensive maintenance program. All hazards or defects identified during inspections should be repaired promptly. All repairs and replacements of equipment parts should be completed in accordance with the manufacturer's instructions. A general checklist that may be used as a guide for frequent routine inspections of public playgrounds is included at Appendix A.

In addition to this general maintenance inspection, more detailed inspections should be conducted on a regular basis. The procedures and schedules for these detailed inspections will depend on the types and amount of equipment on the playground, the level of use, and the local climate, as well as the maintenance instructions provided by equipment manufacturers. Therefore, this checklist is only one of many elements which should be considered in the development of a comprehensive inspection schedule and system of maintenance. Any damage or hazards detected during inspections should be repaired immediately, in accordance with the manufacturer's instructions for repair and replacement of parts.

The checklist at Appendix A is intended to address only general maintenance concerns. It does not provide a complete safety evaluation of equipment design and layout. For example, it does not address the risk of falls from equipment, moving impact incidents, or head entrapment. Therefore, it is essential to use this checklist only for general maintenance purposes. The detailed design recommendations contained in the Handbook should be used to evaluate the safety of each piece of equipment and the playground as a whole.

Complete documentation of all maintenance inspections and repairs should be retained, including the manufacturer's maintenance instructions and any checklists used. A record of any accidents and injuries reported to have occurred on the playground should also be collected. This will help identify potential hazards or dangerous design features which warrant attention.

6. MATERIALS OF MANUFACTURE AND CONSTRUCTION

6.1 Durability and finish

Purchasers should be sure that the equipment is manufactured and constructed only of materials which have a demonstrated record of durability in the playground or similar outdoor setting.

A major concern for playground equipment materials is corrosion or deterioration. Ferrous metals should be painted, galvanized, or otherwise treated to prevent rust.

All paints and other similar finishes must meet the current CPSC regulation for lead in paint [**3**] (0.06% maximum lead by dry weight). Regardless of the material or treatment process, the manufacturer should ensure that the users of playground equipment cannot ingest, inhale, or absorb potentially hazardous amounts of substances as a result of contact with equipment. Purchasers and installers of playground equipment should obtain documentation from the manufacturer that the preservatives or other treatments applied to the equipment would not present a hazard to the consumer.

Wood should either be naturally rot and insect-resistant or treated to avoid such deterioration. The most common wood treatments used in playground equipment are the inorganic arsenicals. Chromated copper arsenate (CCA) is acceptable for use as a treatment of playground equipment wood, if the dislodgeable arsenic on the surface of the wood is minimized. Inorganic arsenicals should be applied by the manufacturer or wood preserver in accordance with the specifications of the American Wood Preservers Association C17 standard. This standard states that the treated wood should be visibly free of residues which may contain high levels of arsenic (the greenish coloration of CCA treated wood is acceptable). Wood preservers and playground equipment manufacturers should practice technologies and procedures that minimize the level of dislodgeable arsenic (arsenic that might be removable from the wood surface by skin contact or wiping with testing materials). CPSC staff has found that technology exists to treat playground equipment wood with CCA so that dislodgeable arsenic is below detectable levels using a protocol designed to detect dislodgeable arsenic [**4**].

Installers, builders, and consumers who perform woodworking operations, such as sanding, sawing, sawdust disposal, on pressure treated wood should read the consumer information sheet often available at the point of sale [**5**]. The sheet contains important health precautions and disposal information.

Creosote, pentachlorophenol, and tributyl tin oxide are too toxic or irritating and should not be used as preservatives for playground equipment wood. Pesticide-containing finishes should also not be used. Other preservatives that have low toxicity and may be suitable for playground equipment wood are copper or zinc naphthenates, and borates.

6.2 Hardware

When installed and tightened in accordance with the manufacturer's instructions, all fasteners, connecting, and covering devices should not loosen or be removable without the use of tools. Lock washers, self-locking nuts, or other locking means should be provided for all nuts and bolts to protect them from detachment. Hardware in moving joints should also be secured against unintentional or unauthorized loosening. In addition, all fasteners should be corrosion resistant and be selected to minimize the likelihood of corrosion to the materials they connect. Bearings used in moving joints should be easy to lubricate or be self-lubricating. All hooks, including S-hooks, should be closed as tightly as possible (see also Section 9.2.1).

6.3 Metal Surfaces

To avoid the risk of contact burn injury in geographical regions where intense sunlight can be expected, bare or painted metal surfaces on platforms and slide beds should be avoided unless they can be located out of the direct rays of the sun. As an alternative to bare or painted metal, platforms may be fabricated from wood or vinyl coated metal and slide beds may be fabricated from plastic (see also Slides, paragraph 9.1.4).

7. GENERAL HAZARDS

There are a variety of general hazards common to many types of playground equipment. The guidelines in this section apply to all elements of the playground.

7.1 Sharp Points, Corners, and Edges

There should be no sharp points, corners, or edges on any components of playground equipment which could cut or puncture children's skin. Frequent inspections are important in order to prevent injuries caused by the exposure of sharp points, corners, or edges due to wear and tear on the equipment.

Wood parts should be smooth and free from splinters. All corners, metal and wood, should be rounded. All metal edges should be rolled or have rounded capping. Special attention to sharp edges on slides, especially metal edges, is warranted. The exit end and the sides along a slide bed can be particularly dangerous if protective measures are not taken (see also Section 9.1.5).

7.2 Protrusions and Projections

Protrusions or projections on playground equipment should not be capable of entangling children's clothing, because such entanglement can cause serious injuries or death by strangulation. Particular attention should be given to avoiding protrusions or projections at the top of slides to minimize the risk of entanglement with clothing. Jackets with hoods and/or drawstrings have been implicated in such entanglement/strangulation incidents.

When tested in accordance with the procedure in Paragraph 7.2.1, no protrusion should extend beyond the face of any of the three gauges having dimensions shown in Figure 1.

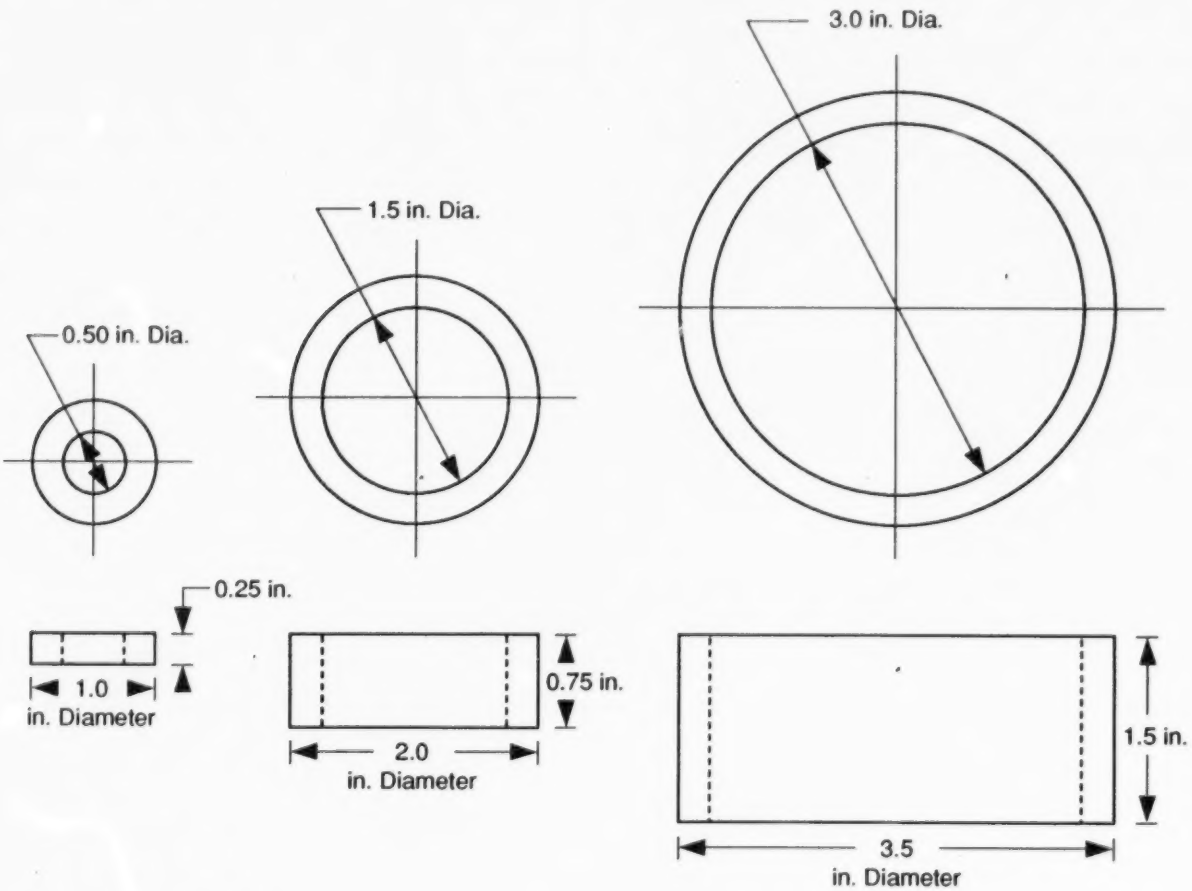


Figure 1 Protrusion Test Gauges

7.2.1 Protrusion Test Procedure

Successively place each gauge (see Figure 1) over any protrusion or projection and determine if it projects beyond the face of the Gauge (see Figure 2).

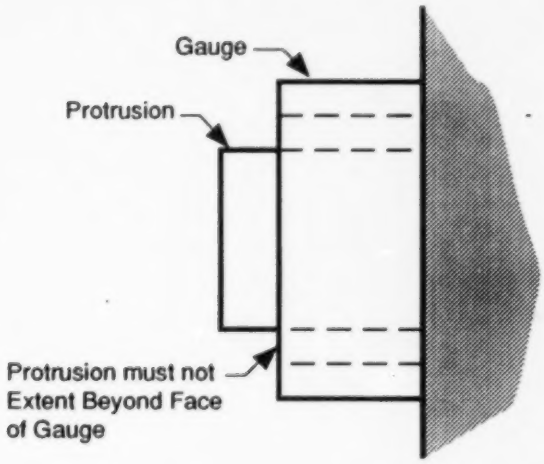


Figure 2 Protrusion Test

7.3 Protrusions on Suspended Members of Swing Assemblies

These form a special case because they can be extremely hazardous, given the potential for impact incidents; therefore, a special test gauge (see Figure 3) and procedure are recommended. No surface in the potential impact region on suspended members should protrude through the hole beyond the face of the specified gauge, when tested in accordance with the following method.

Conduct the test with the suspended member in its rest position. Place the gauge over any protrusion on the front or rear surface of the suspended member such that the axis of the hole in the gauge is parallel to both the intended path of the suspended member and a horizontal plane. Visually determine if the protrusion penetrates through the hole and beyond the face of the gauge.

7.4 Pinch, Crush, and Shearing Points

There should be no accessible pinch, crush, or shearing points on playground equipment that could injure children or catch their clothing. Such points can be caused by components moving relative to each other or to a fixed component when the equipment moves through its anticipated use cycle. To determine if there is a possible pinch, crush or shear point, consider the likelihood of entrapping a body part and the configuration and closing force of the components. Additional information on pinch, crush, and shear points is provided in the recommendations addressing specific pieces of equipment in Section 9.

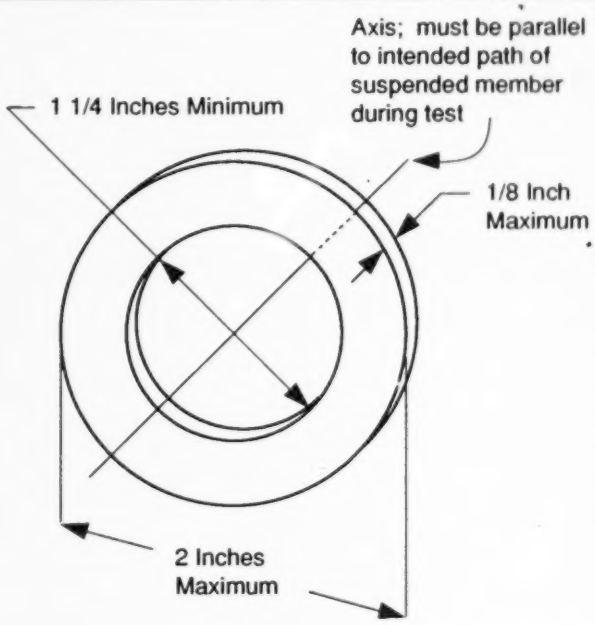

Axis; must be parallel to intended path of suspended member during test
1 1/4 Inches Minimum
1/8 Inch Maximum
2 Inches Maximum
Note: gauge made of any rigid material

Figure 3 Protrusion Test Gauge for Suspended Swing Assemblies

7.5 Entrapment

7.5.1 Head entrapment.

A component or a group of components should not form openings that could trap a child's head. A child's head may become entrapped if the child attempts to enter an opening either feet first or head first. Head entrapment by head-first entry generally occurs when children place their heads through an opening in one orientation, then, after turning their heads to a different orientation, they are unable to withdraw from the opening. Head entrapment by feet-first entry involves children who are generally sitting or lying down and slide their feet into an opening that is large enough to permit passage of their bodies but is not large enough to permit passage of their heads which then become entrapped.

In general, an opening may present an entrapment hazard if the distance between any interior opposing surfaces is greater than 3.5 inches and less than 9 inches. When one dimension of an opening is within this potentially hazardous range, all dimensions of the opening must be considered together to fully evaluate the possibility of entrapment. This recommendation applies to all completely-bounded openings (see Figure B-1 in Appendix B) except where the ground serves as an opening's lower boundary. Further, it applies to all openings regardless of their height above the ground. Even those openings that are low enough to permit children to touch the ground with their feet can present a risk of strangulation for an entrapped child, because younger children may not have the necessary cognitive ability and motor skills to extricate their heads, especially if scared or panicked.

The most appropriate way to determine whether an opening is hazardous is to use test fixtures. Recommended test fixtures, performance requirements, and test methods, are described in Appendix B. These recommendations apply to all playground equipment, both for preschool-age and school-age children. Fixed equipment as well as moving equipment (in its stationary position) should be tested for entrapment hazards. There are two special cases for which separate procedures are given: completely bounded openings where depth of penetration is a critical issue, and openings formed by non-rigid climbing components.

7.5.2 Angles

The angle of any vertex formed by adjacent components should not be less than 55 degrees, unless the lower leg is horizontal or projects downwards (see Figure 4). An exception to this recommendation can be made if a rigid shield is attached to the vertex between adjacent components and the shield is of sufficient size to prevent a 9 inch diameter circular template from simultaneously touching components on either side of the vertex (see Figure 5).

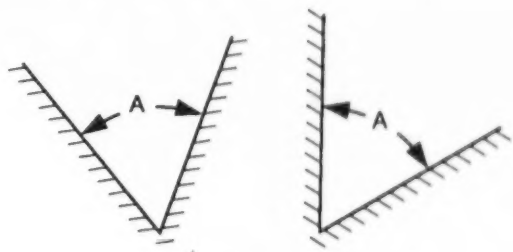
7.6 Tripping Hazards

All anchoring devices for playground equipment, such as concrete footings or horizontal bars at the bottom of flexible climbers, should be installed below the playing surface to eliminate the hazard of tripping. This will also prevent children who may fall from sustaining additional injuries due to exposed footings. In addition, attention should be given to environmental obstacles in the play area, including rocks, roots, and other protrusions from the ground that may cause children to trip.

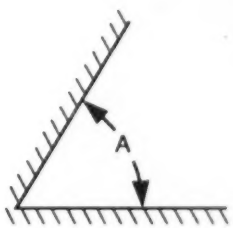
Retaining walls are commonly used to help contain loose surfacing materials. In order to minimize the trip hazard, retaining walls should be highly visible and any change of elevation should be obvious. The use of bright colors can contribute to better visibility.

7.7 Suspended Hazards

Cables, wires, ropes, or similar flexible components suspended between play units or from the ground to a play unit within 45 degrees of horizontal should not be located in areas of high traffic because they may cause



Angle A should exceed 55°



Angle A is exempt if one leg of the vee is horizontal or slopes downward from the apex

Figure 4 Recommendations for Angles

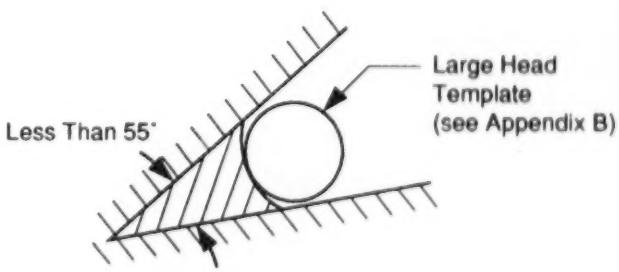


Figure 5 Shield for Angle Less than 55°

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injuries to a running child. It is recommended that these suspended members be either brightly colored or contrast with surrounding equipment to add to their visibility. This recommendation does not apply to suspended members that are located 7 feet or more above the playground surface.

8. ACCESS AND PLATFORMS

8.1 General

Access to playground equipment can take many forms, such as conventional ramps, stairways with steps, and ladders with steps or rungs. Access may also be by means of climbing components, such as climbing nets, arch climbers, and tire climbers (see Figure 6). Such climbing components are typically designed to be more challenging than stairways and stepladders, and so require better balance and coordination of the children. Rung ladders are generally considered to present a level of challenge intermediate between stairways or stepladders and climbing components.

Rung ladders and climbing components such as climbing nets, arch climbers, and tire climbers, should not be used as the sole means of access to equipment intended for preschoolers.

Platforms over 6 feet in height (with the exception of free-standing slides) should provide an intermediate standing surface where a decision can be made to halt the ascent and to pursue an alternative means of descent.

8.2 Stairways and Ladders

Stairways, stepladders, and rung ladders are distinguished by the range of slopes permitted for each of these types of access. However, in all cases the steps or rungs should be evenly spaced, including the spacing between the top step or rung and the surface of the platform. Table 1 contains recommended dimensions for: access slope, tread or rung width, tread depth, rung diameter, and vertical rise for rung ladders, stepladders, and stairways. Table 1 also contains slope and width recommendations for ramps. However, these recommendations are not intended to address ramps designed for access by wheelchairs.

Openings between adjacent steps or rungs and between the top step or rung and underside of a platform should preclude the possibility of entrapment. Risers on stairways and stepladders should be closed if the distance between opposing interior surfaces of consecutive steps is between 3.5 and 9 inches (see Section 7.5). Since the design of rung ladders does not permit risers to be closed, the space between consecutive rungs should not be between 3.5 and 9 inches.

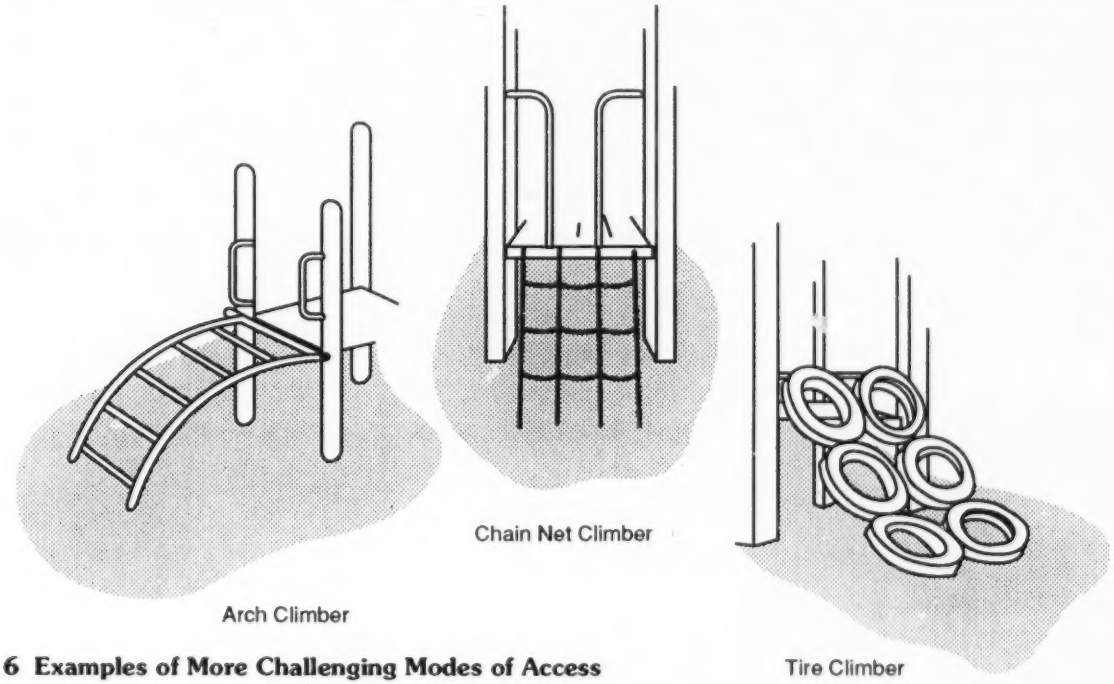


Figure 6 Examples of More Challenging Modes of Access

When risers are closed, treads of stairways and ladders should prevent the accumulation of sand, water, or other materials on or between steps.

8.2.1 Rungs and Other Handgripping Components

Whereas the steps of stairways and stepladders are used only for foot support, the rungs of rung ladders are used for both foot support and for hand support by a climbing child since rung ladders generally do not have handrails.

Rungs are generally round in cross section and should have a diameter or maximum cross sectional dimension between 1 and 1.67 inches. Other components intended to be grasped by the hands such as the bars of climbers should also have a diameter or maximum cross sectional dimension between 1 and 1.67 inches.

Rungs or other handgripping components that are intended to be grasped in a manner such that users will support their entire body weight by their hands should be generally round in cross section with a diameter between 1 and 1.55 inches. To benefit the weakest child in each age group, a diameter of 1.25 inches is preferred.

8.3 Handrails

Handrails on stairways and stepladders are typically intended to provide hand support and to steady the user. Continuous handrails extending over the full length of the access should be provided on both sides of all stairways and stepladders, regardless of the height of the access. Rung ladders do not require handrails since rungs or side supports provide hand support on these more steeply inclined accesses.

TABLE 1
Recommended Dimensions for Access Slope, Tread or Rung Width, Tread Depth, Rung Diameter, and Vertical Rise for Rung Ladders, Stepladders, Stairways, and Ramps.

Type of Access		Age of Intended User 2-5 Years	5-12 Years
Rung Ladders	Slope	75°-90°	75°-90°
	Rung Width	≥ 12"	≥ 16"
	Vertical rise (tread to tread)	≤ 12"**	≤ 12"**
	Rung Diameter	1"-1.67"	1"-1.67"
Stepladders	Slope	50°-75°	50°-75°
	Tread Width - Single File	12"-21"	≥ 16"
	- Two-Abreast	*	≥ 40"
	Tread Depth - Open Riser	≥ 7"	≥ 3"
	- Closed Riser	≥ 7"	≥ 6"
	Vertical Rise (tread to tread)	≤ 9"**	≤ 12"**
Stairways	Slope	≤ 35°	≤ 35°
	Tread Width - Single File	≥ 12"	≥ 16"
	- Two-Abreast	≥ 30"	≥ 40"
	Tread Depth - Open Riser	≥ 7"	≥ 8"
	- Closed Riser	≥ 7"	≥ 8"
	Vertical Rise (tread to tread)	≤ 9"**	≤ 12"**
Ramps (not intended for access by the disabled)	Slope (vertical:horizontal)	≤ 1:8	≤ 1:8
	Width - Single File	≥ 12"	≥ 16"
	- Two-Abreast	≥ 30"	≥ 40"

* Not recommended for preschoolers
** Entrapment provisions apply

8.3.1 Handrail Height

Handrails should be available for use at the appropriate height, beginning with the first step. The vertical distance between the top front edge of a step (tread nosing) and the top surface of the handrail above it should be no less than 22 and no more than 38 inches.

8.3.2 Handrail Diameter

The diameter or maximum cross-sectional dimension of handrails should be between 1 and 1.67 inches.

8.4 Transition from Access to Platform

On any transition from an access mode to a platform, handrails or handholds should be adequate to provide support until the child has fully achieved the desired posture on the platform. Any opening between a handrail and an adjacent vertical structure (e.g., vertical support post for a platform or vertical slat of a protective barrier) should not pose an entrapment hazard (see Section 7.5).

On accesses that do not typically have side handrails, such as rung ladders, flexible climbers, arch climbers, and tire climbers, special attention should be given to providing hand support to facilitate the transition between the top of the access and the platform. Options include vertical handrails and loop handgrips which may extend over the top of the access.

8.5 Platforms

8.5.1 Design Considerations

Platforms should be within $\pm 2°$ of a horizontal plane and openings should be provided to allow for drainage.

8.5.2 Guardrails and Protective Barriers

Either guardrails or protective barriers may be used to prevent inadvertent or unintentional falls off elevated platforms. Protective barriers, however, provide a greater degree of protection in that they should be designed to prevent intentional attempts by children seeking to defeat the barrier either by climbing over or through the barrier.

For example, guardrails may have horizontal rails with openings that are greater than 9 inches. Such openings would not present an entrapment hazard but would not prevent a child from deliberately attempting to climb over or through the openings. On the other hand, a protective barrier should be designed to preclude passage of a child during both inadvertent and intentional attempts to defeat the barrier. Therefore, any openings between uprights or between the platform surface and lower edge of a protective barrier should preclude passage of small torso template (see Appendix B).

8.5.3 Minimum Elevation Requiring Guardrails and Protective Barriers

Guardrails or protective barriers should be provided on platforms, walkways, landings, and transitional surfaces in accordance with the following minimum elevation recommendations.

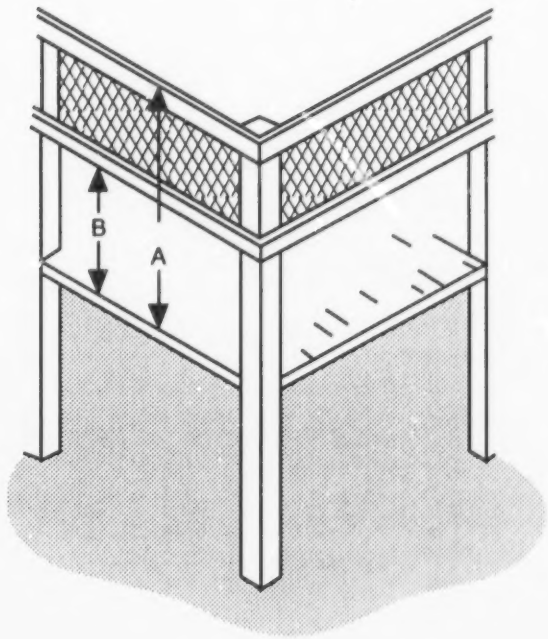
Pre-School Age Children: Since younger children have poorer coordination and balance and are more vulnerable to injury than school-age children, guardrails or protective barriers are warranted at lower elevations. An elevated surface that is more than 20 inches above the underlying surface should have a guardrail or protective barrier to prevent falls. Guardrails are acceptable for platforms greater than 20 inches and less than or equal to 30 inches high, but a full protective barrier may be preferable for this age group since it affords a greater degree of protection from falls. Protective barriers should always be used for platforms that exceed 30 inches in height.

School-Age Children: An elevated surface that is more than 30 inches above the underlying surface should have a guardrail or protective barrier to prevent falls. For platforms greater than 30 inches and less than or equal to 48 inches high, guardrails are acceptable although a full protective barrier always provides greater protection. Platforms that exceed 48 inches in height should always have a protective barrier.

An elevated surface is exempt from these recommendations if a guardrail or protective barrier would interfere with the intended use of the equipment; this includes most climbing equipment, and platforms that are layered so that fall height does not exceed 20 inches on equipment intended for preschool-age children or 30 inches on equipment intended for school-age children.

8.5.4 Minimum Height of Guardrails

The minimum height should prevent the largest child from inadvertently falling over the guardrail. In addition, the guardrail should extend low enough to prevent the smallest child from inadvertently stepping under it (see Figure 7). Infill may be used between the top and intermediate rails to minimize the likelihood of climbing. When solid panels are used as infill, it is recommended that there be some transparent areas to facilitate supervision and to permit viewing from the platform. To prevent head entrapment, guardrails should conform to the entrapment requirements in Section 7.5.



A = 38" minimum for older children

or

29" minimum for younger children

B = 26" maximum for older children

or

23" maximum for younger children

Note: Guardrails should be designed to prevent inadvertent or unintentional falls off the platform, to discourage climbing on the barrier, to preclude the possibility of entrapment, and to facilitate supervision. Refer to text for detailed recommendations regarding infill.

Figure 7 Guardrails on Elevated Surfaces

Pre-School Age Children: the top surface of guardrails should be at least 29 inches high and the lower edge should be no more than 23 inches above the platform.

School Age Children: the top surface of guardrails should be at least 38 inches high and the lower edge should be no more than 26 inches above the platform.

8.5.5 Minimum Height of Protective Barriers

The minimum height should prevent the largest child from inadvertently falling over the protective barrier. In addition, because the protective barrier should not permit children to climb through or under it, openings in the barrier should preclude passage of the small torso template (see Appendix B).

Pre-School Age Children: the top surface of protective barriers should be at least 29 inches high. Vertical infill for protective barriers may be preferable for younger children because the vertical components can be grasped at whatever height a child chooses as a handhold.

School Age Children: the top surface of protective barriers should be at least 38 inches high.

8.5.6 Other Design Considerations for Guardrails and Protective Barriers

Both guardrails and protective barriers should be designed to prevent inadvertent or unintentional falls off the platform, preclude the possibility of entrapment, and facilitate supervision. Horizontal cross-pieces should not be used as infill for the space below the top rail because they provide footholds for climbing.

8.6 Stepped Platforms

On some composite structures, platforms are layered or tiered, so that falls from a higher platform can be terminated by a lower platform rather than by the ground surface.

Unless there is an alternate means of access/egress, the maximum difference in height between stepped platforms should be:

Pre-School Age Children: 12 inches.
School Age Children: 18 inches.

The space between the stepped platforms should follow the recommendations for entrapment in enclosed openings in Section 7.5. If the space exceeds 9 inches and the height of the lower platform exceeds 30 inches for preschool equipment or 48 inches for school-age equipment, infill should be used to reduce the space to less than 3.5 inches.

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9. MAJOR TYPES OF PLAYGROUND EQUIPMENT

9.1 Slides

9.1.1 General

Although children under 6 years of age may be more likely to play on slides, older children will still use slides depending on their availability relative to other types of equipment. Children can be expected to descend slide chutes in many different positions, rather than always sitting and facing forward as they slide. They will slide down facing backward, on their knees, lying on their backs, and will walk both up and down the chute. Younger children in particular often slide down on their stomachs, either head or feet first.

Slides may provide a straight, wavy, or spiral descent either by means of a tube or an open slide bed. They may be either free standing (see Figure 8), part of a composite structure, or built on the grade of a natural or man-made slope (embankment slide). The recommendations in this section do not apply to water slides or swimming pool slides.

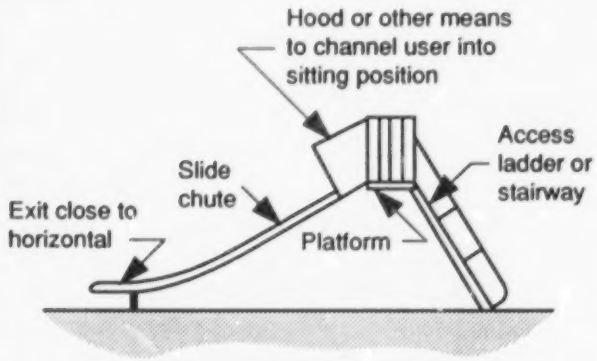

Hood or other means to channel user into sitting position
Access ladder or stairway
Slide chute
Exit close to horizontal
Platform

Figure 8 Typical Free-Standing Straight Slide

9.1.2 Slide Access

With the exception of embankment slides, access to a slide may be by means of a ladder with rungs or steps, a stairway with steps, or the slide may be a component of a composite play structure to which access is provided by other means. Whatever means of access is provided to a slide, it should conform to the guidelines specified in the general discussion of access to all playground equipment (see Section 8).

9.1.3 Slide Platform

All slides should be provided with a platform with sufficient length to facilitate the transition from standing to sitting at the top of the inclined sliding surface. The length of the platform will usually not be an issue when the slide is attached to the deck of a composite structure, because decks are typically at least 3 feet square. However, in the case of a free-standing slide, it is recommended that the platform have a minimum length of at least 22 inches.

The platform should be horizontal and have a width at least equal to the width of the slide.

Guardrails or protective barriers should surround a slide platform and should conform to the guidelines specified in the general discussion of platforms (see Section 8.5).

Slides should not have any spaces or gaps between the platform and the start of the sliding surface.

With the exception of tube slides, handholds should be provided at the entrance to all slides to facilitate the transition from standing to sitting and decrease the risk of falls. These should extend high enough to provide hand support for the largest child in a standing position, and low enough to provide hand support for the smallest child in a sitting position.

At the entrance to the chute there should be a means to channel a user into a sitting position. This may be a guardrail, a hood, or other device. Whatever means is provided, it should be of a design that does not encourage climbing.

9.1.4 Sliding Section of Straight Slides

It is recommended that the average incline of the sliding surface should not exceed 30° and any change in the slope of the slide chute (wave slide) should not allow a child to lose contact with the sliding surface

Straight slides with flat open chutes should have sides with a 4 inch minimum height extending along both sides of the chute for the entire length of the inclined sliding surface.

The sides should be an integral part of the chute, without any gaps between the sides and the sliding surface.

Slides may have an open chute with a circular cross section providing that the height of the sides, measured from the lowest point on the chute is no less than half the width of the slide.

Metal slides should either be in shaded areas or face north to prevent burns and glare problems caused by direct sun on the slide chute.

9.1.5 Exit Region

All slides should have an exit region to help children maintain their balance and facilitate a smooth transition from sitting to standing when exiting.

The exit region should be essentially horizontal and parallel to the ground and have a minimum length of 11 inches.

For slides that are no more than 4 feet in height, the height of the exit region should be no more than 11 inches from the protective surface.

For slides that are over four feet in height the exit region should be at least 7 inches but not more than 15 inches above the protective surface.

Slide exit edges should be rounded or curved, to prevent lacerations or other injuries which could result from impact with a sharp or straight edge.

All slide exits should be located in uncongested areas of the playground.

9.1.6 Embankment Slides

The design of embankment slides basically eliminates the hazard of falls from height. Embankment slides should follow all of the recommendations given for straight slides (where applicable). It is important that some means be provided at the slide chute entrance to minimize the likelihood that they will be used by children riding skateboards or bicycles.

9.1.7 Spiral Slides

It is recommended that spiral slides follow the recommendations for straight slides (where applicable), with special attention given to design features which may present problems unique to spiral slides, such as lateral discharge of the user.

Preschool-Age Children: Because younger children have less ability to maintain balance and postural control, only short spiral slides are recommended for this age group.

9.1.8 Tube Slides

Tube slides should meet all the applicable requirements for other slides.

Barriers should be provided or surfaces treated to prevent sliding on the top of the tube.

The minimum internal diameter of the tube should be no less than 23 inches.

It should be noted that children using tube slides are not visible to a supervisor. Consideration should be given to extra supervision on playgrounds having tube slides.

9.1.9 Roller Slides

These are not recommended for public playgrounds unless frequent maintenance can be guaranteed.

9.2 Swings

9.2.1 General

Children of all ages generally enjoy the sensations created while swinging. Most often, they sit on the swings, and it is common to see children jumping off swings. Younger children tend to also swing on their stomachs, and older children may stand on the seats.

Swings may be divided into two distinct types, single axis of motion and multiple axes of motion. A single axis swing is intended to swing back-and-forth in a single plane and generally consists of a seat supported by at least two suspending members each of which is connected to a separate pivot on an overhead structure. A multiple-axis swing consists of a seat (generally a tire) suspended from a single pivot that permits it to swing in any direction.

Hardware used to secure the suspending elements to the swing seat and to the supporting structure should not be removable without the use of tools. S-hooks are often part of a swing's suspension system, either attaching the suspending elements to the overhead support bar or to the swing seat. Open S-hooks are hazardous because they can catch a child's clothing and result in strangulation. S-hooks should be pinched closed as tightly as possible.

Swings should be suspended from support structures that discourage climbing. A-frame support structures should not have horizontal cross-bars.

9.2.2 Single Axis Swings

To help prevent young children from inadvertently running into the path of moving swings, swing structures should be located away from other equipment or activities. Additional protection can be provided by means of a low barrier, such as a fence or hedge. Such barriers

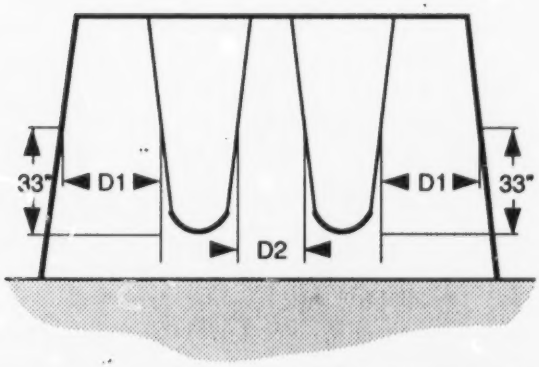
should not be an obstacle within the use zone of a swing structure or hamper supervision by blocking visibility.

To minimize the likelihood of children being struck by a moving swing, it is recommended that no more than two single axis swings be hung in each bay of the supporting structure.

Attaching single-axis swings to composite structures is not recommended.

Swing seats should be designed to accommodate no more than one user at any time. To help reduce the severity of impact injuries, wood or metal swing seats are not recommended. Edges of seats should have smoothly finished or rounded edges and should conform to the protrusion recommendations in Section 7.3.

To minimize collisions between swings or between a swing and the supporting structure, the clearances shown in Figure 9 are recommended. In addition, to reduce side-to-side motion, swing hangers should be spaced wider than the width of the swing seat.



D1 = Minimum 30"
D2 = Minimum 24"

Figure 9 Minimum Clearances for Swings

9.2.3 Tot Swings

These are single axis swings intended for very young children to use with adult assistance. The seats and suspension systems of these swings, including the related hardware, should follow all of the other criteria for conventional single axis swings.

Tot swing seats should provide support on all sides of a child (see Figure 10). It is important that such supports do not present a strangulation hazard. Openings in tot swing seats should conform to the entrapment criteria in Section 7.5.

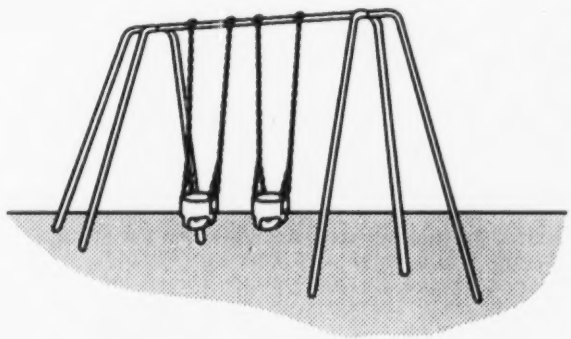


Figure 10 Examples of Tot Swings

It is recommended that tot swings be suspended from structures which are separate from those for other swings, or at least suspended from a separate bay of the same structure.

9.2.4 Multi-Axis Tire Swings

Tire swings are typically suspended in a horizontal orientation using three suspension chains or cables connected to a single swivel mechanism that permits both rotation and a swinging motion in any axis.

A multi-axis tire swing should not be suspended from a structure having other swings in the same bay.

To minimize the hazard of impact, heavy truck tires should be avoided. Further, if steel-belted radials are used, they should be closely examined to ensure that there are no exposed steel belts that could be a potential protrusion or laceration hazard. Plastic materials can be used as an alternative to simulate actual automobile tires. Drainage holes should be provided in the underside of the tire.

The likelihood of hanger mechanism failure is increased for tire swings, due to the added stress of rotational

movement and multiple occupancy. Special attention to maintenance is warranted. The hanger mechanisms for multi-axis tire swings should not have any accessible pinch points.

The minimum clearance between the seating surface of a tire swing and the uprights of the supporting structure should be 30 inches when the tire is in a position closest to the support structure (see Figure 11).

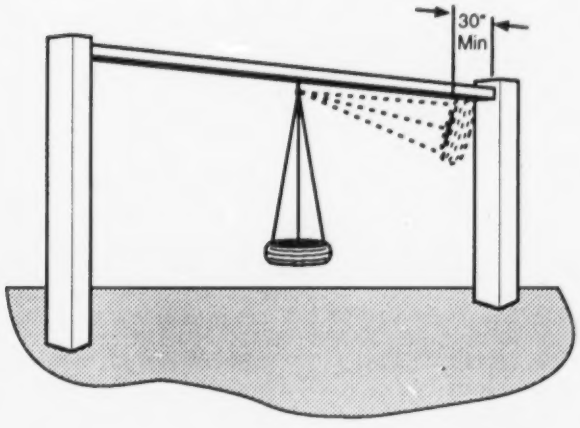


Figure 11 Multi-Axis Tire Swing Clearance

9.2.5 Swings Not Recommended for Public Playgrounds

The following types of swings are not recommended for use in public playgrounds:

Multiple Occupancy Swings - With the exception of tire swings, swings that are intended for more than one user are not recommended because their greater mass, as compared to single occupancy swings, presents a risk of impact injury.

Animal Figure Swings - These are not recommended because their rigid metal framework results in a high mass presenting a risk of impact injury.

Rope Swings - Free swinging ropes that may fray or otherwise form a loop are not recommended because they present a potential strangulation hazard.

Swinging Exercise Rings and Trapeze Bars - These are generally considered to be items of athletic equipment and are not recommended for public playgrounds. NOTE: The recommendation against the use of exercise rings does not apply to overhead hanging rings (see Figure 12).

9.3 Climbing Equipment

9.3.1 General

Climbers refer to a wide variety of equipment including arch climbers, sliding poles, chain or net climbers, upper body devices (overhead horizontal ladders, overhead rings), dome climbers, parallel bars, balance beams, cable walks, suspension bridges, and spiral climbers, as well as composite structures with linked platforms (see Figure 12 for examples). Climbing equipment is generally designed to present a greater degree of physical challenge than other equipment on public playgrounds.

Older children tend to use climbing equipment more frequently and proficiently than younger ones. Because very young children have not yet developed some of the physical skills necessary for certain climbing activities (including balance, coordination, and upper body strength), they may have difficulty using more challenging climbing components such as rung ladders, non-rigid climbers, arch climbers, and upper body devices.

9.3.2 Design Considerations

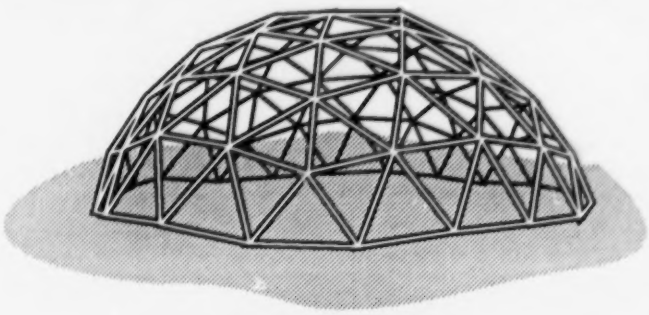
Since the more challenging modes of access discussed in Section 8 are also intended to be used as climbing devices, the recommendations for the size of handgripping components and stepped platforms covered in that section are applicable to climbing equipment.

Climbers should not have climbing bars or other structural components in the interior of the structure onto which a child may fall from a height of greater than 18 inches.

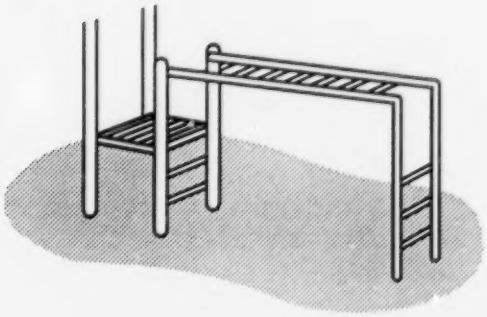
Climbing equipment should allow children to descend as easily as they ascend. One way of implementing this recommendation is to provide an easier, alternate means of descent, such as another mode of access, platform, or piece of equipment. For example, a stairway can be added to provide a less challenging mode of descent than a vertical rung ladder or flexible climbing device. The levels of challenge that characterize different types of accesses are discussed in Section 8.

Preschool-Age Children Offering an easy way out is particularly important on climbing devices intended for preschoolers, since their ability to descend climbing components emerges later than their ability to climb up the same components.

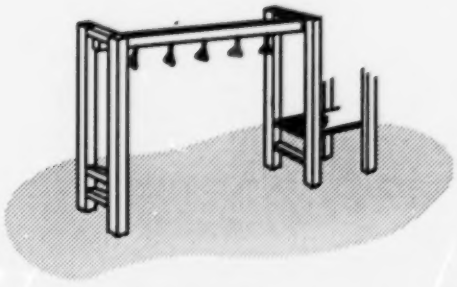
Simple Arch Climber



Geodesic Dome Climber



*Overhead Horizontal Ladder



*Overhead Hanging Rings

*Note: This design shows how upper body equipment is typically integrated with multi-use equipment.

Figure 12 Typical Climbing Equipment

9.3.3 Climbers With Non-Rigid Components

Net and chain climbers use a flexible grid of ropes or chains for climbing. Tire climbers are also described as flexible climbers. These may have the tires secured tread-to-tread in the form of a sloping grid or the tires may be suspended individually by chains or other means to provide access to an elevated platform. Since net, chain, and tire climbers have flexible components that do not provide a steady means of support, and therefore require more advanced balance abilities than conventional ladders, they require special consideration.

Flexible grid climbing devices which provide access to platforms should be securely anchored at both ends. When one end is connected to the ground, the anchoring devices shall be below the level of the playing surface.

Connections between ropes, cables, or chains within the climbing grid or between tires should be securely fixed. Spacing between the horizontal and vertical components of a climbing grid should satisfy all entrapment criteria (see Section 7.5).

Flexible grid climbing devices are not recommended as the sole means of access to equipment intended for preschool-age children.

9.3.4 Arch Climbers

Arch climbers consist of metal or wood rungs attached to convex side supports. They may be free standing (see Figure 12) or be provided as a more challenging means of access to other equipment (see Figure 6). Because of this extra challenge, they should not be used as the sole means of access to other equipment. A less challenging option will ensure that children use the arch climber because they are willing to assume the challenge and not because they are forced to use it. Free standing arch climbers are not recommended for preschool-age children.

The rung diameter and spacing of rungs on arch climbers should follow the recommendations for rung ladders in Table 1.

9.3.5 Horizontal Ladders and Overhead Rings

Four year olds are generally the youngest children capable of using upper body devices such as these. The recommendations below are, therefore, designed to accommodate children 4 through 12 years of age.

The space between adjacent rungs of overhead ladders should be greater than 9 inches to satisfy the entrapment requirements (see Section 7.5). The center-to-center spacing of horizontal ladder rungs should not exceed 15 inches. This does not apply to the spacing of overhead rings because, during use, the gripped ring swings through an arc and reduces the distance to the gripping surface of the next ring.

The first handhold on either end of upper body equipment should not be placed directly above the platform or climbing rung used for mount or dismount. This minimizes the risk of children impacting rigid access structures if they fall from the first handhold during mount or dismount.

9.3.6 Sliding Poles

Vertical sliding poles are designed to be more challenging than some other types of climbing equipment. They are not recommended for preschool-age children who may lack the requisite upper body strength and coordination to successfully slide down the pole. Furthermore, once younger children have grasped the pole, they would be forced to slide down it since there is no alternative option.

Sliding poles should be continuous with no protruding welds or seams along the sliding surface and the pole should not change direction along the sliding portion.

The horizontal distance between a sliding pole and the edge of the platform or other structure used for access to the sliding pole should be at least 18 inches. This minimum distance applies to all points down the sliding pole.

All points on the sliding pole at or above the level of the access structure, where a child is likely to reach for the pole, should not be more than 20 inches away from the edge of the access structure.

The pole should extend at least 38 inches above the level of the platform or other structure used for access to the sliding pole.

The diameter of sliding poles should be no greater than 1.9 inches.

The design of the access structure should minimize the possibility of interference from surrounding traffic that may be out of the line of sight of a user during descent.

9.3.7 Climbing Ropes

Individual vertically suspended climbing ropes are recommended only if they are securely anchored to a footing at the lower end to prevent the rope from being looped back on itself and forming a noose.

9.3.8 Balance Beams

To avoid groin injuries during falls, balance beams should be no higher than 12 inches.

9.3.9 Layout of Climbing Components

When climbing components are part of a composite structure, their level of challenge and mode of use should be compatible with the traffic flow from adjacent components.

The swinging movements generated on upper body devices warrant special precautions to reduce the risk of impact with children on adjacent structures. Upper body devices should be placed so that swinging children cannot interfere with the movement of children on adjacent structures, particularly with their descent on slides.

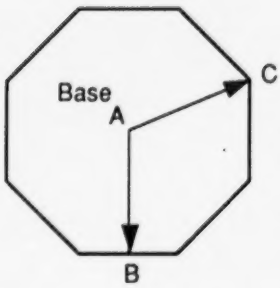
The design of adjacent play structures should not facilitate climbing to the top support bars of upper body equipment.

9.4 Merry-Go-Rounds

Merry-go-rounds are the most common type of rotating equipment found on public playgrounds. Children usually sit or stand on the platform while other children or adults push the merry-go-round to make it rotate. In addition, children often get on and off the merry-go-round while it is in motion.

Merry-go-rounds may present a physical hazard to preschool-age children who have little or no control over such products once they are in motion. Merry-go-rounds are not recommended unless the following are observed:

The rotating platform should be continuous and approximately circular. The difference between the minimum and maximum radii of a non-circular platform should not exceed 2.0 inches (see Figure 13). No components of the apparatus, including handgrips, should extend beyond the perimeter of the platform.



A = Axis of Rotation
AB = Minimum Radius
AC = Maximum Radius

The difference between dimensions AC and AB should not exceed 2.0 inches.

Figure 13 Minimum and Maximum Radii of Non-Circular Merry-Go-Round Platform

Children should be provided with a secure means of holding on. Where handgrips are provided, they should conform to the general requirements for handgripping components in Section 8.2.1.

There should not be any accessible shearing or crushing mechanisms in the undercarriage of the equipment. The rotating platform of a merry-go-round should not have any sharp edges. The surface of the platform should be continuous with no openings between the axis and the periphery that permit a rod having a diameter of 5/16 inch to penetrate completely through the surface.

A means should be provided to limit the peripheral speed of rotation to a maximum of 13 ft/sec.

Merry-go-round platforms should not be provided with an oscillatory (up and down) motion.

9.5 Seesaws

The typical seesaw (also known as a "teeter totter") consists of a board or pole supported at the center by a fulcrum and having a seat at each end (see Figure 14). Seesaw use is quite complex because it requires two children to cooperate and combine their actions. Younger children do not generally have the skills required to effectively use fulcrum seesaws. Therefore, they are not recommended on public playgrounds for preschool-age children unless they are equipped with a spring centering device to prevent abrupt contact with the ground should one child elect to dismount.

There is a trend to replace fulcrum seesaws on public playgrounds with spring-loaded seesaws, which have the advantage of not requiring two children to coordinate their actions in order to play safely (see discussion of Spring Rocking Equipment in Section 9.6).

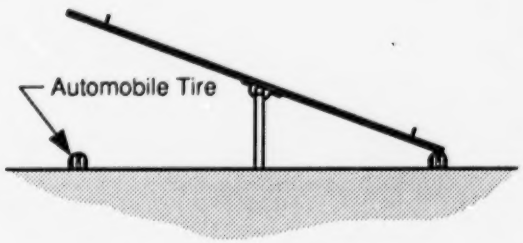


Figure 14 Typical Fulcrum Seesaw

The fulcrum of fulcrum seesaws should not present a pinch or crush hazard.

Partial car tires, or some other shock-absorbing material, should be embedded in the ground underneath the seats of fulcrum seesaws, or secured on the underside of the seats. This will help prevent limbs from being crushed between the seat and the ground, as well as cushion the impact. Fulcrum see-saws may also be equipped with a spring centering mechanism to minimize the risk of injury due to impact with the ground.

Handholds should be provided at each seating position for gripping with both hands and should not turn when grasped. Handholds should not protrude beyond the sides of the seat. Footrests should not be provided on fulcrum see-saws unless they are equipped with a spring centering mechanism to minimize the likelihood of impact with the ground.

9.6 Spring Rocking Equipment

Younger children enjoy the bouncing and rocking activities presented by this equipment, but older children typically do not find it challenging enough.

Examples of spring rockers are shown in Figure 15. Preschoolers are the primary users of such rocking equipment. Therefore, the recommendations in this section address only preschool-age children.

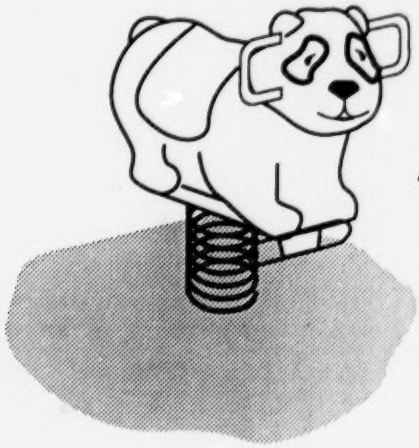
Seat design should minimize the likelihood of the rocker being used by more than the intended number of users.

Each seating position should be equipped with handgrips and footrests. The diameter of handgrips should follow the general recommendations for handgripping components in Section 8.5.2.

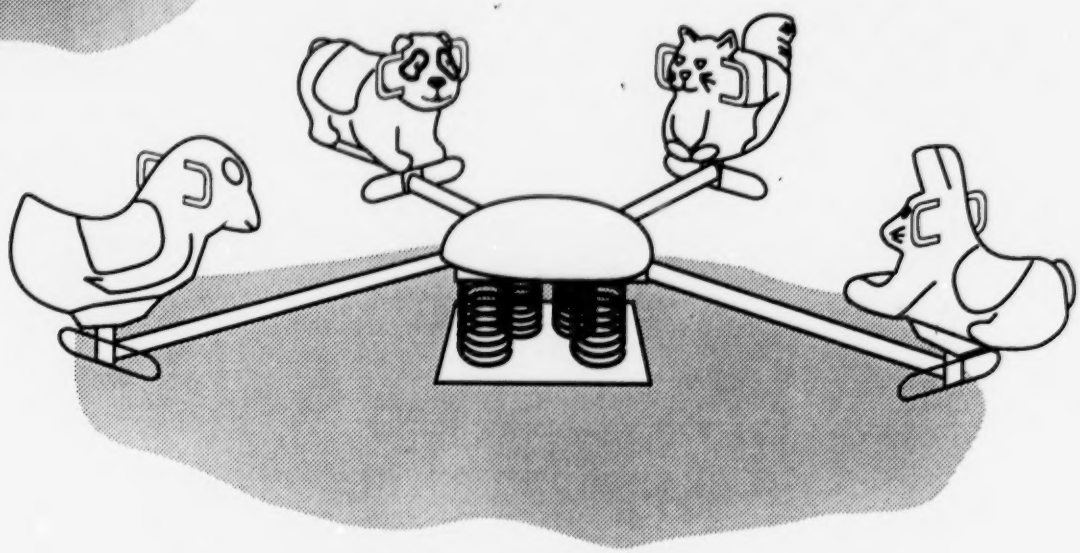
The springs of rocking equipment should minimize the possibility of children pinching either their hands or their feet between coils or between the spring and a part of the rocker.

9.7 Trampolines

Trampolines are not recommended for use on public playgrounds.



Animal Spring Rocker



4-Way Spring-Loaded Seesaw

Figure 15 Typical Spring Rocking Equipment

10. SURFACING

The surface under and around playground equipment can be a major factor in determining the injury-causing potential of a fall. It is self evident that a fall onto a shock absorbing surface is less likely to cause a serious injury than a fall onto a hard surface. Because head impact injuries from a fall have the potential for being life threatening, the more shock absorbing a surface can be made, the more is the likelihood that the severity of the injury will be reduced. However, it should be recognized that all injuries due to falls cannot be prevented no matter what playground surfacing material is used.

10.1 Determining Shock Absorbency of a Surfacing Material

No data are available to predict precisely the threshold tolerance of the human head to an impact injury. However, biomedical researchers have established two methods that may be used to determine when such an injury may be life threatening.

One method holds that if the peak deceleration of the head during impact does not exceed 200 times the acceleration due to gravity (200 G's), a life threatening head injury is not likely to occur. The second method holds that both the deceleration of the head during impact and the time duration over which the head decelerates to a halt are significant in assessing head impact injury. This latter method uses a mathematical formula to derive a value known as Head Injury Criteria (HIC) [6]. Head impact injuries are not believed to be life threatening if the HIC does not exceed a value of 1,000.

The most widely used test method for evaluating the shock absorbing properties of a playground surfacing material is to drop an instrumented metal headform onto a sample of the material and record the acceleration/time pulse during the impact. Such a method is described in an ASTM Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment, ASTM F1292 [7].

10.2 Critical Height

This is a term originating from Europe and is used to describe the shock absorbing performance of a surfacing material. As it is used in this publication, the Critical Height for a surfacing material is defined as **the maximum height from which the instrumented metal headform, upon impact, yields both a peak deceleration of no more than 200 G's and a HIC of no more than 1,000 when tested in accordance with the procedure described in ASTM F1292.** Critical Height, therefore, can be considered as an approximation of the maximum fall height from which a life-threatening head injury would not be expected to occur.

The surfacing material used under and around a particular piece of playground equipment should have a Critical Height value of at least the height of the highest accessible part of the equipment.

10.3 Highest Accessible Part of Equipment

Recommendations for the "highest accessible part" for various pieces of playground equipment are as follows.

Swings - Since children may fall from a swing seat at its maximum attainable angle (assumed to be 90° from the "at rest" position), the highest accessible part of a swing structure is the height of the pivot point where the swing's suspending elements connect to the supporting structure.

Elevated Platforms Including Slide Platforms - Since children may climb onto or over guardrails, the highest accessible part of a platform surrounded by guardrails is the height above the playing surface of the top of the guardrail . Since protective barriers are designed to minimize the likelihood of climbing, the highest accessible part of a platform surrounded by protective barriers is the height of the platform surface above the ground.

Climbers and Horizontal Ladders - For structures that are intended to be climbed upon, the highest accessible part is the maximum height of the structure.

Merry-Go-Rounds - The highest accessible part is the height above the ground of any part at the perimeter on which a child may sit or stand.

See-Saws - The highest accessible part is the maximum height attainable by any part of the see-saw.

Spring Rockers - The highest accessible part is the maximum height above the ground of the seat or designated play surface.

10.4 Acceptability of Various Surfacing Materials

Hard surfacing materials, such as asphalt or concrete, are unsuitable for use under and around playground equipment of any height unless they are required as a base for a shock absorbing unitary material such as a rubber mat. Earth surfaces such as soils and hard packed dirt are also not recommended because their shock absorbing properties can vary considerably depending on climatic conditions such as moisture and temperature. Similarly, grass

and turf are not recommended because their effectiveness in absorbing shock during a fall can be reduced considerably due to wear and environmental conditions.

Acceptable playground surfacing materials are available in two basic types, **unitary** or **loose-fill**.

Unitary Materials - are generally rubber mats or a combination of rubberlike materials held in place by a binder that may be poured in place at the playground site and cures to form a unitary shock absorbing surface. Unitary materials are available from a number of different manufacturers many of whom have a range of materials with differing shock absorbing properties. Persons wishing to install a unitary material as a playground surface should request test data from the manufacturer that should identify the Critical Height of the desired material. In addition, site requirements should be obtained from the manufacturer because, as stated above, some unitary materials require installation over a hard surface while for others this is not required.

Loose-Fill Materials - can also have acceptable shock absorbing properties when installed at a sufficient depth. These materials include, but are not confined to, sand, gravel, and shredded wood products. Loose-fill materials should not be installed over hard surfaces such as asphalt or concrete.

Because loose-fill materials are generally sold for purposes other than playground surfacing, many vendors are unlikely to be able to provide information on their shock absorbing performance. For that reason, CPSC staff has conducted tests to determine the relative shock absorbing properties of some loose-fill materials commonly used as surfaces under and around playground equipment. Appendix D contains a description of the tested materials. The tests were conducted in accordance with the procedure in the voluntary standard for playground surfacing systems, ASTM F1292. Table 2, below, lists the critical height (expressed in feet) for each of seven materials when tested in an uncompressed state at depths of 6, 9, and 12 inches. The table also reports the critical height when a 9 inch depth of each material was tested in a compressed state.

The table should be read as follows: If, for example, uncompressed wood mulch is used at a minimum depth of 6 inches, the Critical Height is 7 feet. If 9 inches of uncompressed wood mulch is used, the Critical height is 10 feet. It should be noted that, for some materials, the Critical Height decreases when the material is compressed.

TABLE 2
Critical Heights (in feet) of Tested Materials

Material	Uncompressed depth 6 inch	Uncompressed depth 9 inch	Uncompressed depth 12 inch	Compressed depth 9 inch
Wood Mulch	7	10	11	10
Double Shredded Bark Mulch	6	10	11	7
Uniform Wood Chips	6	7	>12	6
Fine Sand	5	5	9	5
Coarse Sand	5	5	6	4
Fine Gravel	6	7	10	6
Medium Gravel	5	5	6	5

The Critical Heights shown in the above table may be used as a guide in selecting the type and depth of loose-fill materials that will provide the necessary safety for equipment of various heights. There may be other loose-fill materials such as bark nuggets or shredded tires that have shock absorbing properties equivalent to those in the above table. However, no tests have been conducted on these materials by CPSC staff.

The depth of any loose fill material could be reduced during use resulting in different shock-absorbing properties. For this reason, a margin of safety should be considered in selecting a type and depth of material for a specific use.

10.5 Accessibility to the Disabled

The Americans with Disabilities Act of 1990 (ADA) prohibits discrimination on the basis of disability in employment, public services, transportation, public accommodations - including many services operated by private entities, - and telecommunications. Title III of the legislation includes within the definition of public accommodation: "a park, zoo, amusement park, or other place of recreation"; a school, including nursery schools; a day care center; and a gymnasium, health spa, or "other places of exercise or recreation."

Specific Federal requirements for accessibility to playgrounds by the disabled are expected to be published.

The Department of Parks and Recreation in the State of California has advised that after January 1, 1991, regulations requiring that all types of play activity in new and redone play areas must be accessible to the disabled. Other states may similarly issue accessibility requirements. Playground designers, installers and operators are reminded that they should determine what Federal and State requirements for accessibility are in effect. These requirements could necessitate changes to existing playgrounds as well as when new playgrounds are planned or existing playgrounds refurbished.

10.6 Other Characteristics of Surfacing Materials

Selection of a surfacing material for a specific location may be governed by the environmental conditions at that location. Appendix C lists some characteristics of surfacing materials that may influence the choice for a particular playground.

USE ZONES FOR EQUIPMENT

The use zone for each piece of equipment is made up of two parts:

(1) the Fall Zone: an area under and around the equipment where protective surfacing is required, and,

(2) the No-Encroachment Zone: an additional area beyond the fall zone where children using the equipment can be expected to move about and should have no encroaching obstacles.

With the exception of spring rocking equipment, equipment under 24 inches in height, and the zone between adjacent swings (see below), the fall zones of adjacent pieces of equipment should not overlap. However, adjacent pieces of equipment may share a single no-encroachment zone.

Regardless of the type of equipment, the use zone should be free of obstacles that children could run into or fall on top of and thus be injured. For example, there should not be any vertical posts or other objects protruding from the ground onto which a child may fall.

11.1 Recommendations for Fall Zone

11.1.1 Stationary Equipment

The fall zone should extend a minimum of 6 feet in all directions from the perimeter of the equipment.

11.1.2 Slides

The fall zone in front of the access and to the sides of a slide shall extend a minimum of 6 feet from the perimeter of the equipment. Note: This does not apply to embankment slides.

The fall zone in front of the exit of a slide shall extend a minimum distance of 6 feet from the end of the slide chute or for a distance of H + 4 feet whichever is the greater. H is the height of the slide platform and the H + 4 foot measurement is made from a point on the slide chute where the gradient has been reduced to 5° from the horizontal (see Figure 16).

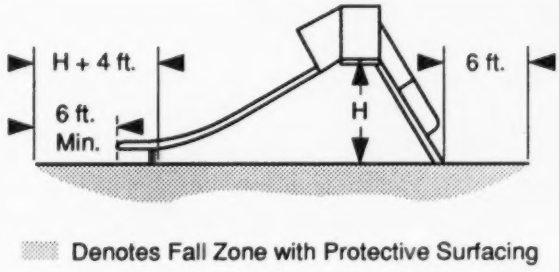
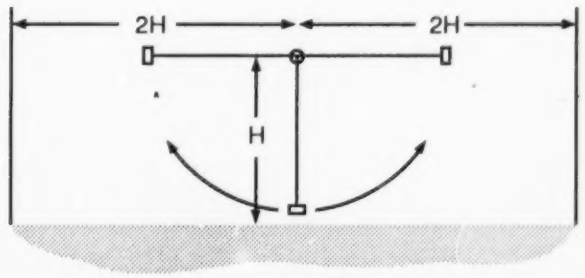


Figure 16 Fall Zone for Slides

11.1.3 Single Axis Swings

Because children may deliberately attempt to exit from a single axis swing while it is in motion, the fall zone in front of and behind the swing should be greater than to the sides of such a swing. It is recommended that the fall zone extend to the front and rear of a single axis swing a minimum distance of 2 times the height of the pivot point above the surfacing material measured from a point directly beneath the pivot on the supporting structure (see Figure 17). The fall zone to the sides of a single axis swing should follow the general recommendation and extend a minimum of 6 feet from the perimeter of the swing structure in accordance with the general recommendation for fall zones. This 6 foot zone may overlap that of an adjacent swing structure.



Denotes Fall Zone with Protective Surfacing

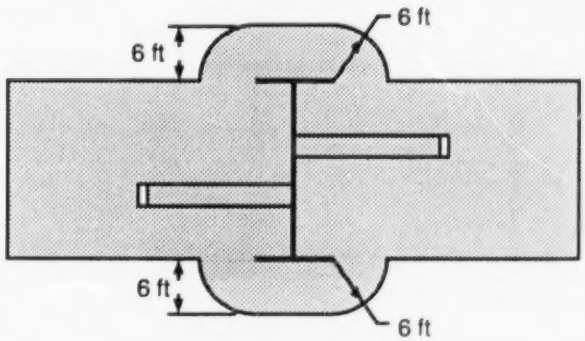


Figure 17 Fall Zone for Single Axis Swings

11.1.4 Multi Axis Swings

The fall zone should extend in any direction from a point directly beneath the pivot point for a minimum distance of 6 feet + the length of the suspending members (see Figure 18). In addition, the fall zone shall extend a minimum of 6 feet from the perimeter of the supporting structure. This 6 foot zone may overlap that of an adjacent swing structure.

11.1.5 Merry-Go-Rounds

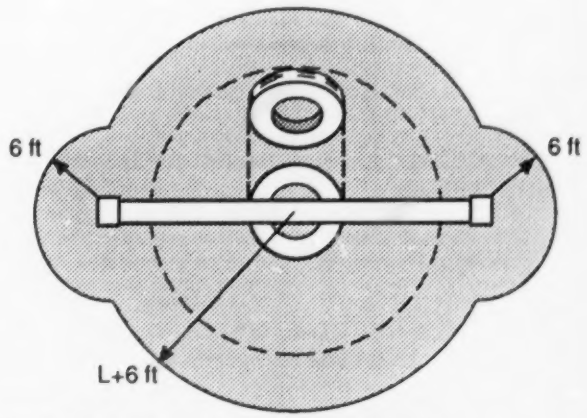
The fall zone should extend 6 feet beyond the perimeter of the platform.

11.1.6 Spring Rocking Equipment

The fall zone should extend a minimum of 6 feet from the "at rest" perimeter of the equipment but adjacent spring rockers with a maximum seat height of 24 inches may share the same fall zone.

11.1.7 Composite Equipment

The above recommendations for individual pieces of equipment should be used as a guide in establishing the fall zones around pieces of composite playground equipment. Note that in Section 9.2.2 it was recommended that single axis swings not be a part of a composite structure.



Denotes Fall Zone with Protective Surfacing

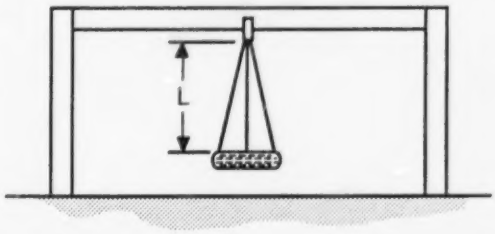


Figure 18 Fall Zone for Multi Axis Tire Swings

11.2 Recommendations for No-Encroachment Zone

No specific dimensions can be recommended for the no-encroachment zone around individual pieces of playground equipment. These dimensions will vary according to the types of adjacent pieces of equipment and their orientation with respect to one another.

For example, the recommended fall zone at the side of both a slide and a swing is 6 feet. Since fall zones should not overlap (with the exception of certain adjacent spring rockers), a slide could be placed with its side no closer than 12 feet to the side of a swing. Therefore, there may be no need to add an additional no-encroachment zone. Conversely, it would not be desirable to have a slide exit facing the front or rear of single axis swing.

No-encroachment zones extending beyond the fall zones are recommended for moving equipment or equipment from which the child is in motion as he or she exits. This

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allows more space for children to regain their balance upon exiting the equipment and also provides added protection against other children running into a moving part.

For a single axis swing, it is recommended that there be a barrier beyond the fall zone in front of the swing if it is located in a playground facing other pieces of equipment.

REFERENCES

1.Ratte, Donna J., Morrison, Melanie L., Lerner, Neil D., *Development of Human Factors Criteria for Playground Equipment Safety*; COMSIS Corporation, March 1990.

2.Tinsworth, Deborah Kale, Kramer, John T., *Playground Equipment-Related Injuries and Deaths*; U. S. Consumer Product Safety Commission, Washington D.C. 20207, April 1990.

3.Title 16, Code of Federal Regulations, Part 1303; *Ban of Lead-Containing Paint and Certain Consumer Products Bearing Lead-Containing Paint*; Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

4.Lee, Brian C., *Estimote of Risk of Skin Cancer from Dislodgeable Arsenic on Pressure Treated Wood Playground Equipment*; U.S. Consumer Product Safety Commission, Washington, D.C. 20207, January 1990.

5.*Consumer Information Sheet: Inorganic Arsenical Pressure-Treated Wood*; American Wood Preservers Institute, 1945 Gallows Road, Suite 550, Vienna, Virginia 22182.

6.Collantes, Margarita, *Evaluation of the Importance of Using Head Injury Criterion (HIC) to Estimate the Likelihood of Head Impact Injury as a Result of a Fall Onto Playground Surface Materials*; U.S. Consumer Product Safety Commission, Washington, D.C. 20207, October 1990.

7.*Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment, ASTM F1292*; ASTM, 1916 Race Street, Philadelphia, PA 19103.

APPENDIX A

SUGGESTED GENERAL MAINTENANCE CHECKLIST

General Upkeep of Playgrounds

Check the entire playground area for miscellaneous debris or litter.

Check for missing trash receptacles and for those which are full.

Check for any damage (i.e., any broken or missing components) to equipment or other playground features caused by vandalism or wear; for example, check for any broken or missing handrails, guardrails, protective barriers, or steps or rungs on ladders, and for damage to any fences, benches, or signs on the playground.

Surfacing

Check for equipment which does not have adequate protective surfacing under and around it and for surfacing materials that have deteriorated.

Check loose surfacing materials for foreign objects or debris.

Check loose surfacing materials for compaction and reduced depth, with special attention to heavy use areas such as those under swings and slide exit regions.

General hazards

Check all equipment and other playground features for any hazards which may have emerged.

Check for sharp points, corners, and edges; for example check the sides and sliding surface of slide chutes for sharp or rough edges caused by deterioration.

Check for protrusions and projections.

Check for missing or damaged protective caps or plugs.

Check for potential clothing entanglement hazards, such as open S-hooks.

Check for pinch, crush, and shearing points or exposed moving parts.

Check for trip hazards, such as exposed footings on anchoring devices and rocks, roots, or any other environmental obstacles in the play area.

Deterioration of Equipment

Check all equipment and other playground features for rust, rot, cracks, and splinters, with special attention to possible corrosion where structures come in contact with the ground.

Check for unstable anchoring of equipment.

Security of hardware

Check for any loose or worn connecting,covering, or fastening hardware devices: for example, check the S-hooks at both ends of suspending elements of swings and all connection points on flexible climbing devices for wear.

Check all moving parts, such as swing bearing hangers, for wear.

Equipment use zones

Check for obstacles in equipment use zones.

Drainage systems

Check the entire play area for drainage problems, with special attention to heavy use areas such as those under swings and slide exit regions.

APPENDIX B

ENTRAPMENT REQUIREMENTS AND TEST METHODS

B1. General

Any completely-bounded opening (see Figure B-1) may be a potential head entrapment hazard and should conform to the recommendations in this appendix. One exception to these recommendations is an opening where the ground serves as the lower boundary. Openings in both horizontal and vertical planes present a risk of entrapment. Even those openings which are low enough to permit a child's feet to touch the ground present a risk of strangulation to an entrapped child, because younger children may not have the necessary cognitive ability and motor skills to extricate their heads, especially if scared or panicked.

An opening may present an entrapment hazard if the distance between any interior opposing surfaces is greater than 3.5 inches or less than 9 inches; when one dimension of an opening is within this potentially hazardous range, all dimensions of the opening must be considered together to fully evaluate the possibility of entrapment. The most appropriate method to determine whether an opening is hazardous is to test it using the following fixtures, methods, and performance criteria.

These recommendations apply to all playground equipment, both for preschool-age and school-age children; fixed equipment as well as moving equipment (in its stationary position) should be tested for entrapment hazards. There are two special cases for which separate procedures are given: completely-bounded openings where depth of penetration is a critical issue (see Figure B-2); and openings formed by non-rigid climbing components.

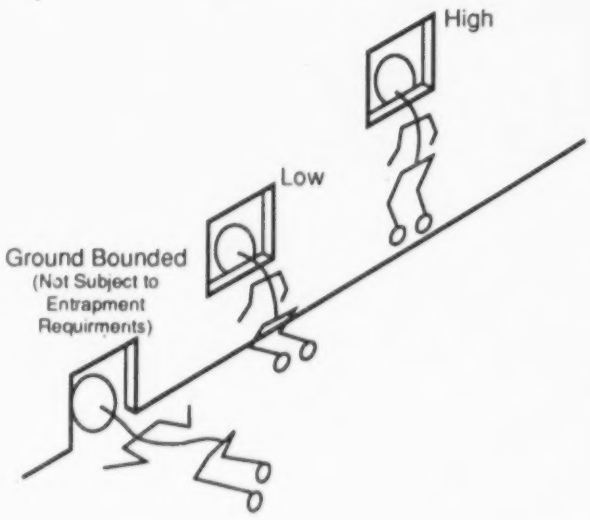


Figure B-1 Examples of Completely Bounded Openings

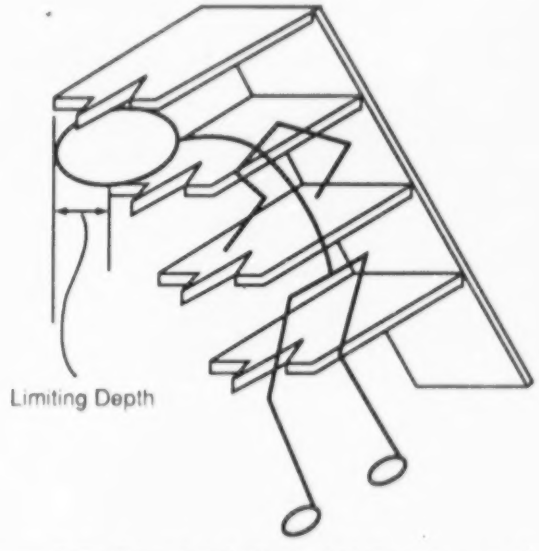


Figure B-2 Completely Bounded Openings with Limited Depth

B2. Test fixtures

Two templates are required to determine if completely bounded openings in rigid structures present an entrapment hazard.

B2.1 Small Torso Template

The dimensions (see Figure B-3) of this template are based on the size of the torso of the smallest user at risk. If an opening is too small to admit the template, it is also too small to permit feet first entry by a child. Because children's heads are larger than their torsos, an opening that does not admit the small torso probe will also prevent head first entry into an opening by a child.

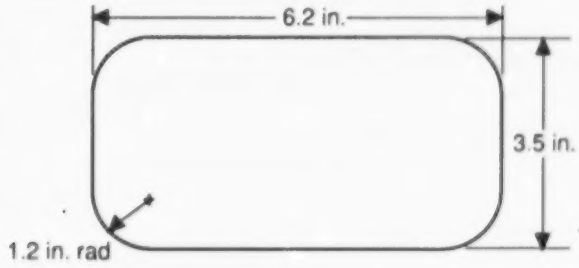


Figure B-3 Small Torso Template

B2.2 Large Head Template

The dimensions (see Figure B-4) of this template are based on the largest dimension on the head of the largest child at risk. If an opening is large enough to permit free passage of the template, it is large enough to permit free passage of the head of the largest child at risk in any orientation. In addition, openings large enough to permit free passage of the Large Head Template also will not entrap the chest of the largest child at risk.

B3. Requirement

When tested in accordance with the procedure in B4. below, an opening conforms to the requirement if:

(1) the opening does not admit the Small Torso Template,

or

(2) the opening admits the Small Torso Template and also admits the Large Head Template.

An opening fails to conform to the requirement if it admits the Small Torso Template but does not admit the Large Head Template.

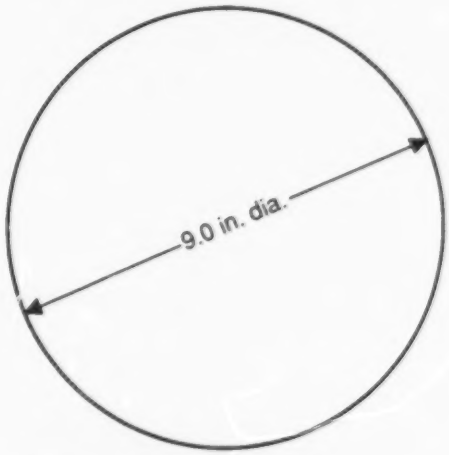


Figure B-4 Large Head Template

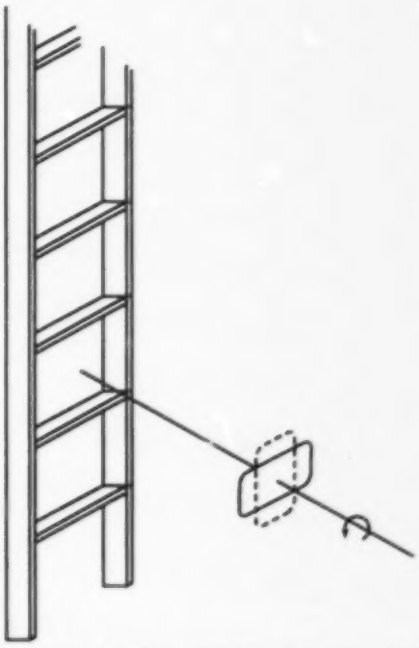
B4. Test Procedure

Attempt to place the Small Torso Template in the opening with the plane of the template parallel to the plane of the opening. While keeping it parallel to the plane of the opening, the template should be rotated to its most adverse orientation i.e. major axis of template oriented parallel to the major axis of the opening. If the Small Torso Template can be freely inserted through the opening, place the Large Head Template in the opening, again with the plane of the template parallel to the plane of the opening, and attempt to freely insert it through the opening. The test procedure is illustrated in Figure B-5.

B5. Completely-bounded openings where depth of penetration is a critical issue

The configuration of some openings may be such that the depth of penetration is a critical issue for determining the entrapment potential. This is a special case for which separate test procedures are necessary.

For example, consider a vertical wall or some other barrier behind a stepladder. The entrapment potential depends not only on the dimensions of the opening between adjacent steps but also on the horizontal space between the lower boundary of the opening and the barrier. A child may enter the opening between adjacent steps feet first and may proceed to pass through the space between the rear of the lower step and the barrier and become entrapped when the child's head is unable to pass through either of these two openings. In effect, there are openings in two different planes each of which has the potential for head entrapment and must, therefore, be tested.



Test procedures and performance criteria for completely-bounded openings.

Place the Small Torso Template in the opening with the plane of the template parallel to the plane of the opening. Rotate the template while keeping it parallel to the opening.

If the Small Torso Template can be inserted into the opening, place the Large Head Template into the opening so its plane is parallel to the plane of the opening.

An opening can pass this test when tested in accordance with the above procedures in one of two ways. 1) the opening does not admit the Small Torso Template when it is rotated to any orientation about its own axis, or 2) the opening admits the Small Torso Template and also admits the Large Head Template. An opening fails the test under the following conditions: the opening admits the Small Torso Template but does not admit the Large Head Template.

Figure B-5 Entrapment Test for Completely-Bounded Openings

Figure B-6 illustrates these two planes for a stepladder as well as for a generic opening. Plane A is the plane of the completely bounded opening in question and Plane B is the plane of the opening encompassing the horizontal space between the lower boundary of the opening in Plane A and the barrier that must also be tested for conformance to the entrapment requirements.

The procedures and performance criteria for testing openings where the depth of penetration is a critical issue depend on a series of questions, as described below.

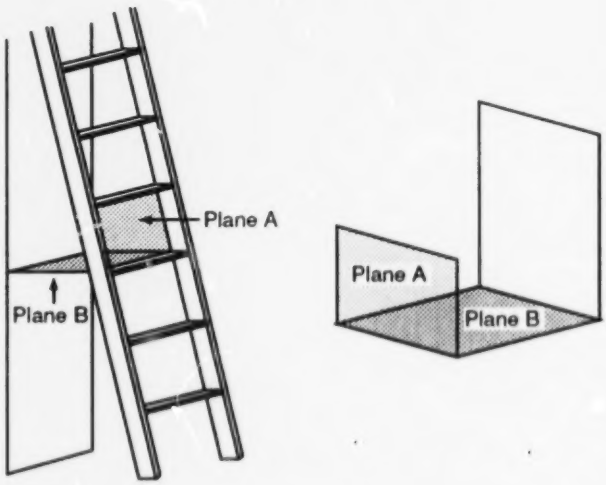


Figure B-6 Examples of Completely-Bounded Openings Where Depth of Penetration is a Critical Issue

The first step is to determine whether or not the smallest user at risk can enter the opening in Plane A. The Small Torso Template is used to test this opening as follows:

Place the Small Torso Template in the opening in Plane A with its plane parallel to Plane A; rotate the template to its most adverse orientation with respect to the opening while keeping it parallel to Plane A. Does the opening in Plane A admit the Small Torso Template in any orientation when rotated about its own axis?

NO - If the opening in Plane A does not admit the Small Torso Template in any orientation, then the opening is small enough to prevent either head first or feet first entry by the smallest user at risk and is not an entrapment hazard. The opening conforms to the requirements.

YES - If the opening in Plane A admits the Small Torso Template, then the smallest user at risk can enter the opening in Plane A. The entrapment potential depends on whether or not the smallest user at risk can also enter the opening in Plane B. The Small Torso Template is again used to test this opening as follows:

With the plane of the Small Torso Template parallel to the opening in Plane B and with the template's major axis (i.e., the 6.2-inch dimension) parallel to Plane A, does the opening in Plane B admit the the Small Torso Template?

NO - If the opening in Plane B does not admit the Small Torso Template, then it is small enough to prevent head or feet first entry by the smallest user at risk. Therefore the depth of penetration into the opening in plane A is insufficient to result in entrapment of the smallest user at risk. The opening conforms to the requirements.

YES - If the opening in Plane B admits the Small Torso Template, then the smallest user at risk can enter the opening in Plane B feet first. The entrapment potential depends on whether or not the Large Head Template can exit the opening in Plane A when tested as follows:

Place the Large Head Template in the opening in Plane A with its plane parallel to Plane A. Does the opening in Plane A admit the Large Head Template?

NO - If the opening in Plane A does not admit the Large Head Template, then a child whose torso can enter the opening in Plane A as well as the opening in Plane B, may become entrapped by the head in the opening in Plane A. The opening fails to conform to the requirements.

YES - If the opening in Plane A admits the Large Head Template, then the largest user at risk can exit the opening in Plane A. The entrapment potential depends on whether or not the largest user at risk can also exit the opening in Plane B. The Large Head Template is used to test this as follows:

With the plane of the Large Head Template parallel to the opening in Plane B, does the opening in Plane B admit the Large Head Template?

NO - If the opening in Plane B does not admit the Large Head Template, then the largest user at risk cannot exit the opening in Plane B. This presents an entrapment hazard because a child's torso may enter the openings in Plane A and Plane B, and a child's head may pass through the opening in Plane A but become entrapped in the opening in Plane B. The opening fails to conform to the requirements.

YES - If the opening in Plane B admits the Large Head Template, then the largest user at risk can exit the opening in Plane B so there is no entrapment hazard. The openings in Plane A and Plane B conform to the requirements.

B6. Non-rigid openings

Climbing components such as flexible nets are also a special case for the entrapment tests because the size and shape of openings on this equipment can be altered when force is applied, either intentionally or simply when a child climbs on or falls through the openings. Children are then potentially at risk of entrapment in these distorted openings.

B6.1 Test Fixtures

The procedure for determining conformance to the entrapment requirements for non-rigid openings requires two three-dimensional test probes which are illustrated in Figures B-7 and B-8 and are applied to an opening in a non-rigid component with a force of up to 50 pounds.

B6.2 Requirements

When tested in accordance with the procedure in B6.3 below, a non-rigid opening may conform to the requirements in one of two ways:

(1) The opening does not permit complete passage of the Small Torso Probe when tested in accordance with the prodedure in B6.3 below.

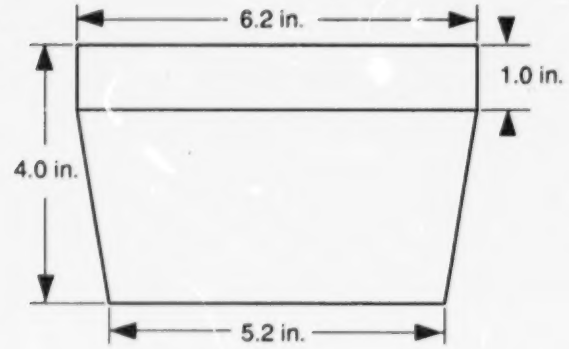
(2) The opening allows complete passage of the Small Torso Probe and the Large Head Probe when tested in accordance with the procedure in B6.3 below.

A non-rigid opening does not conform to the entrapment requirements if it allows complete passage of the Small Torso Probe but does not allow complete passage of the Large Head Probe.

B6.3 Test Procedure

Place the Small Torso Probe in the opening, tapered end first, with the plane of its base parallel to the plane of the opening. While keeping its base parallel to the plane of the opening, rotate the probe to its most adverse orientation (major axis of probe parallel to major axis of opening). Determine whether the probe can be pushed or pulled through the opening by a force no greater than 50 pounds. If the Small Torso Probe cannot pass completely through the opening, it conforms to the requirements.

If the Small Torso Probe passes completely through the opening, place the Large Head Probe in the opening with the plane of its base parallel to the plane of the opening. Again attempt to push or pull the probe through the opening with a force no greater than 50 pounds. If the Large Head Probe can pass completely through the opening, it conforms to the requirements.



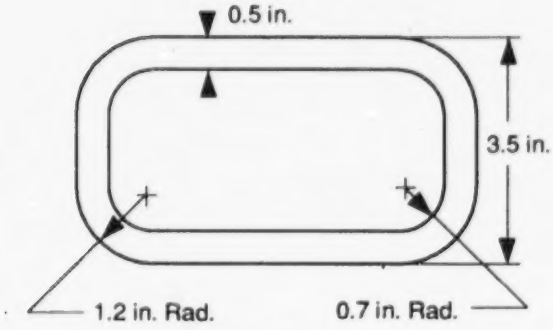
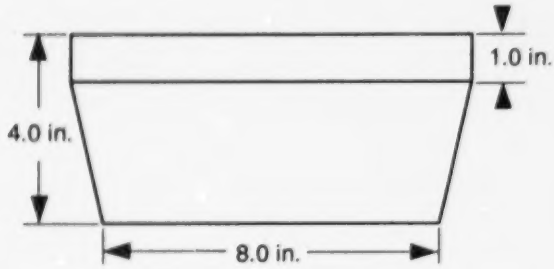


Figure B-7 Small Torso Probe



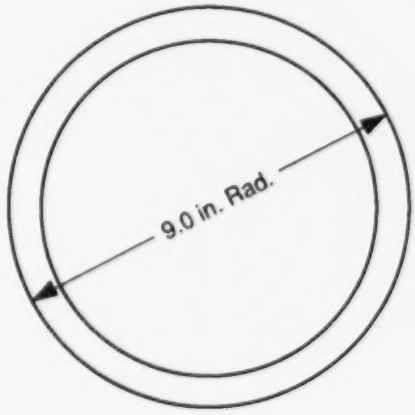


Figure B-8 Large Head Probe

APPENDIX C

SUMMARY CHARACTERISTICS OF ORGANIC AND INORGANIC LOOSE-FILL MATERIALS, AND UNITARY SYNTHETIC MATERIALS

ORGANIC LOOSE MATERIAL

wood chips, bark mulch, etc.

Fall Absorbing Characteristics

Cushioning effect depends on air trapped within and between individual particles, and presupposes an adequate depth of material. See Table 2 for performance data.

Installation/Maintenance

Should not be installed over existing hard surfaces (e.g., asphalt, concrete).
Requires a method of containment (e.g.,retaining barrier, excavated pit).
Requires good drainage underneath material.
Requires periodic renewal or replacement and continuous maintenance (e.g., leveling, grading, sifting, raking) to maintain appropriate depth and remove foreign matter.

Advantages

Low initial cost.
Ease of installation.
Good drainage.
Less abrasive than sand.
Less attractive to cats and dogs (compared to sand).
Attractive appearance.
Readily available.

Disadvantages

The following conditions may reduce cushioning potential:

1. Environmental conditions: rainy weather, high humidity, freezing temperatures.
2. With normal use over time, combines with dirt and other foreign materials.
3. Over time, decomposes, is pulverized, and compacts.
4. Depth may be reduced by displacement due to children's activities or by material being blown by wind.

Can be blown or thrown into children's eyes.
Subject to microbial growth when wet.
Conceals animal excrement and trash (e.g., broken glass, nails, pencils, and other sharp objects that can cause cut and puncture wounds).
Spreads easily outside of containment area.
Can be flammable.
Subject to theft by neighborhood residents for use as mulch.

INORGANIC LOOSE MATERIAL
sand and gravel

Fall Absorbing Characteristics

See Table 2 for performance data.

Installation/Maintenance

Should not be installed over existing hard surfaces (e.g., asphalt, rock).
Method of containment needed (e.g., retaining barrier, excavated pit).
Good drainage required underneath material.
Requires periodic renewal or replacement and continuous maintenance (e.g., leveling, grading, sifting, raking) to maintain appropriate depth and remove foreign matter.
Compacted sand should periodically be turned over, loosened, and cleaned.
Gravel may require periodic break up and removal of hard pan.

Advantages
Low initial cost.
Ease of installation.
Does not pulverize.
Not ideal for microbial growth.
Nonflammable.
Materials are readily available.
Not susceptible to vandalism except by contamination.
Gravel is less attractive to animals than sand.

Disadvantages

The following conditions reduce cushioning potential:

1. Environmental conditions: rainy weather, high humidity, freezing temperatures.

2. With normal use, combines with dirt and other foreign materials.

3. Depth may be reduced due to displacement by children's activities and sand may be blown by wind.

May be blown or thrown into children's eyes.
May be swallowed.
Conceals animal excrement and trash (e.g., broken glass, nails, pencils, and other sharp objects that can cause cut and puncture wounds).

Sand:

Spreads easily outside of containment area.
Small particles bind together and become less cushioning when wet; when thoroughly wet, sand reacts as a rigid material.
May be tracked out of play area on shoes; abrasive to floor surfaces when tracked indoors; abrasive to plastic materials.
Adheres to clothing.
Susceptible to fouling by animals.

Gravel:

Difficult to walk on.
If displaced onto nearby hard surface pathways, could present a fall hazard.
Hard pan may form under heavily traveled areas.

UNITARY SYNTHETIC MATERIALS
rubber or rubber over foam mats or tiles,
poured in place urethane and rubber compositions

Fall Absorbing Characteristics

Manufacturer should be contacted for information on Critical Height of materials when tested according to ASTM F1292.

Installation/Maintenance

Some unitary materials can be laid directly on hard surfaces such as asphalt or concrete.
Others may require expert under-surface preparation and installation by the manufacturer or a local contractor.
Materials generally require no additional means of containment.
Once installed, the materials require minimal maintenance.

Advantages

Low maintenance.
Easy to clean.
Consistent shock absorbency.
Material not displaced by children during play activities.
Generally low life cycle costs.
Good footing (depends on surface texture).
Harbor few foreign objects.
Generally no retaining edges needed.
Is accessible to the handicapped.

Disadvantages

Initial cost relatively high.
Undersurfacing may be critical for thinner materials.
Often must be used on almost level uniform surfaces.
May be flammable.
Subject to vandalism (e.g., ignited, defaced, cut).
Full rubber tiles may curl up and cause tripping.
Some designs susceptible to frost damage.

APPENDIX D

DESCRIPTION OF LOOSE FILL SURFACING MATERIALS IN TABLE 2

1. Wood Mulch - Random sized wood chips, twigs, and leaves collected from a wood chipper being fed tree limbs, branches, and brush.

2. Double Shredded Bark Mulch - Similar to shredded mulch commonly used by homeowners to mulch shrubs and flower beds.

3. Uniform Wood Chips - Relatively uniform sized shredded wood fibers from recognized hardwoods. Sample contained no bark or leaves.

4. Fine Sand - Particles of white sand purchased in bags marked "play sand." The material was passed through wire-cloth screens of different sizes in accordance with ASTM Standard Method C136-84a and yielded the following results:

Screen Size	Percent Passing Through Screen
#16	100
#30	98
#50	62
#100	17
#200	0-1

5. Coarse Sand - Sample was obtained from a supplier to the landscaping and construction trades. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
#4	98
#8	73
#16	4
#30	1
#50	0-1

6. Fine Gravel - Sample was obtained from a supplier to the residential landscaping market. Gravel particles were rounded and were generally less than 3/8 inch in diameter. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
3/8 inch	100
#3 1/2	93
#4	65
#8	8
#16	5
#30	4

7. Medium Gravel - Particles were rounded as found in river washed or tumbled stone. ASTM C136-84a test results were:

Screen Size	Percent Passing Through Screen
1/2 inch	100
3/8 inch	80
5/16 inch	58
#3 1/2	20
#4	8
#8	7
#16	3

For further information, write:

U.S. Consumer Product Safety Commission
Washington, D.C. 20207

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